THE MODEL ENGINEER

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The MODEL ENGINEER

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SMOKE RINGS

Our Cover Picture

● ONE OF the duties which are part of the normal routine of locomotive motive power depots is the clearing of "char," or ash, from the smokeboxes of locomotives as they come to the depot for a "breather" after a trip on the road. Today, there are, at some depots, means of doing the ash-removal by means of steam jets from an outside steam supply; but the hand method depicted in the photograph is still very commonly found. This particular example was "caught" by the camera of Mr. C. R. L. Coles, at a Southern Region depot; the engine is 4-6-0 No. 30790, *Sir Villiars*, of the King Arthur class. The engine's own blower is full on, the jets of steam being just visible above the blast-pipe, inside the smokebox. This helps to prevent the escape of a great deal of dust.

A Novel Form of Entertainment

● IT IS usual at annual dinners and similar functions where formality is anything but the order of the day (or evening), for some kind of entertainment to be provided for the enjoyment of all present. At the annual dinner of the Newbury Model Engineering Club, we found that the genial and hospitable hon. secretary, Mr. G. W. Allinson, had thought up something that was very much out of the ordinary. Certain selected members and guests were, without warning, presented with a typewritten script which, at the duly appointed time, proved to be part of a mock debate, and had to be read to the assembled company.

The idea had been well planned beforehand; a certain member had been chosen to act as chairman of the proceedings, though his "appointment" was not revealed to him prior to the event. The subject of the debate was: "The Case for a Mechanical Secretary"; the "chairman" opened it with a few well-chosen comments carefully prepared for him and read by him from the sheet of paper which had been presented to him by Allinson. He then gave a suitable cue to each selected guest, in turn, who read from his or her sheet of notes, making any appropriate additions or alterations which were thought of on the spur of the moment. Some eight or ten contributions of this kind were duly delivered, with hilarious results, and showed that all the trouble which had gone into their preparation was well worth while. As a "one-man show," shared by so many of the guests, it undoubtedly carried the evening.

We would add, however, that this was not the only item of the programme; much local talent had been recruited to provide songs, anecdotes, etc., which were much enjoyed.

A Novel Prize for a Locomotive

● MESSRS. DICK SIMMONDS & CO., of Erith, are offering one of their injectors to be awarded as a prize at this year's "M.E." Exhibition. It will be awarded to what the judges shall decide to be the best miniature locomotive not fitted with an injector. This is quite a novel idea, but it is intended to stimulate further confidence in small injectors, since there still seems to be quite an unwarranted amount of prejudice against these useful fitments.

In prototype practice, the injector is universal as the means of keeping a boiler fed with the necessary supply of water; but in miniature locomotives the hand-pump is frequently the only method of boiler feeding, which is not only out of date but unrealistic. We are not suggesting that the hand-pump should be abandoned entirely, but it should be regarded simply as a stand-by, for use only when the injector, or other method of boiler feed, refuses to work.

Coloured Plates of Pre-grouping Locomotives

● IN ORDER to meet an ever-growing demand for particulars of the colours of locomotives of the pre-grouping era, Messrs. Percival Marshall & Co. Ltd. are shortly bringing out a series of coloured plates. Each plate will be in the form of a four-page folder and will include the coloured illustration, a colour chart, a 4-mm. scale line-drawing, a table of the principal dimensions and some descriptive and historical notes. The folders will be available either separately or in sets of five in a stiff-backed envelope; the price will be 2s. each or 10s. per set, including postage.

The original paintings from which the plates have been prepared are the work of Mr. Richard Ward, and the drawings have been, in some cases, specially made and, in other cases, taken from a variety of sources.

The plates should appeal not only to model locomotive builders, but to all who are in any way interested in locomotive history. The first set includes locomotives of the L.N.W.R., S.E. & C.R., G.N.R., L.B. & S.C.R. and G.W.R., covering the period 1870-1900.

The "Magic" Blueprint !

● IT HAS always been the policy of THE MODEL ENGINEER to furnish as accurate and complete information as possible on the design of models, and in addition to the drawings published in this journal, many of the popular designs have been produced in the form of fully-detailed blueprints, either to full size, or to an easily convertible scale, with full dimensions. It appears, however, quite impossible to satisfy the demand for more and more blueprints of every conceivable subject, and many of our readers appear to have an implicit faith in the ability of the blueprint to solve all constructional problems.

In this respect, it would appear that the importance of the blueprint may sometimes be overrated. It is, perhaps, not without significance that the term "blueprint" has beome a part of the portentous official vocabulary with which we have become all too familiar in recent years. One often hears that a "blueprint" of a certain industrial or political scheme has been produced, the implication being that everything has been planned to the last detail, and that all difficulties connected with it are solved. Similarly, many of our readers seem to imagine that there is about a blueprint some magic which will enable them to dispense with their own intelligence and resourcefulness! Blueprints are asked for in connection with many schemes which are only capable of being solved by the individual concerned.

The definite function of the blueprint or, to be strictly correct, the engineering drawing, is to give accurate details and dimensions of a piece of mechanism, or other clear-cut engineering job, in which function, it serves a useful and indeed an indispensable purpose; but it should never be regarded as a substitute for engineering skill and intelligence.

The Passing of a Pioneer

● FURTHER TO our "Smoke Ring" of last week, Mr. E. T. Westbury, Associate Editor of THE MODEL ENGINEER, has contributed the following :—"Few people have done more to promote accuracy in timekeeping than Mr. F. Hope-Jones, whose recent death will be regretted by all who are interested in horology and its allied sciences. The particular invention for which he is best known is the Synchronome constant-impulse electric clock, which, in addition to being one of the most successful devices for measuring and transmitting time, has set an entirely new standard in accuracy and synchronism in timekeepers in offices and public buildings. Upon this foundation, further progress has been made in existing means of time measurement and distribution, culminating in the practical realisation of the horologist's long-cherished dream—the free pendulum, which represents the nearest possible approach to the ideal timekeeper. Mr. Hope-Jones also carried out considerable research in the design of astronomical clocks, and the distribution of time signals by radio and other means. The familiar 'six pips,' which are transmitted daily by the B.B.C., were originally made possible by his endeavours. In common with most other great thinkers, he had a keen appreciation of the virtues of simplicity; his ideal clock was one having the very minimum of mechanical or electrical complication. This is a direct contrast to the elaborate and polyfunctional clocks on which many horologists have spent a lifetime of endeavour, and which are often indifferent timekeepers. He was also keenly interested in model engineering, and was a personal friend of the late Mr. Percival Marshall. When the Synchronome clock was first produced, the castings and parts for its construction were made available to model engineers, and many examples of home-constructed Synchronome clocks have been built, and still feature in model engineering exhibitions. Mr. Hope-Jones was the author of many authoritative publications on horology, and electric clocs in particular, including the 'M.E.' handbook *Electric Clocks and How to Make Them.* Though his death is an irreparable loss to horological science, the results of his work will continue to be felt in the gradual improvement in design of timekeeping instruments, and the accuracy of their performance."

A Locomotive Chassis in Ten Days

by G. F. Tonnstein

SOMEONE once asked me why it was that the locomotive fraternity always carried cans of tea about with them when engaged on duties—it did not seem to matter whether they were going on or coming off duty, the can of steaming tea always seemed to be close at hand. This easy question was soon answered, but, said my questioner, "Why tea ?" and no matter what reason I gave, I soon found that my questioner had already weighed up all the pros and cons and had failed to find a really satisfactory answer. Even my retort that perhaps the canteen only supplied tea was rejected with the comment "Only boiling water is added to a lot of tea cans—the tea is already *in* the can." I have forgotten now the ultimate finish of the discussion, but I can now say that the preliminary discussions held by the Malden Society's committee, which eventually lead to the building of a 5-in. gauge 4-4-0 locomotive chassis in the ten days of the 1949 MODEL ENGINEER Exhibition took place over cups of *coffee*. The building of the locomotive chassis itself, however, called for tea—and plenty of it, something like thirty very large jugs of tea disappeared down the throats of the builders during the ten days. Perhaps tea has a good internal lubricating quality, I know that it was much appreciated and may have been very materially responsible for the effort made by the Malden Society's members who actually turned out some 500 parts for this chassis (and other parts of the locomotive) during the ten days. This effort was not, however, turned out only on tea, it was much more involved, and in the course of this article, I will endeavour to outline briefly the many problems and the daily progress made which enabled this venture to be brought to a satisfactory conclusion.

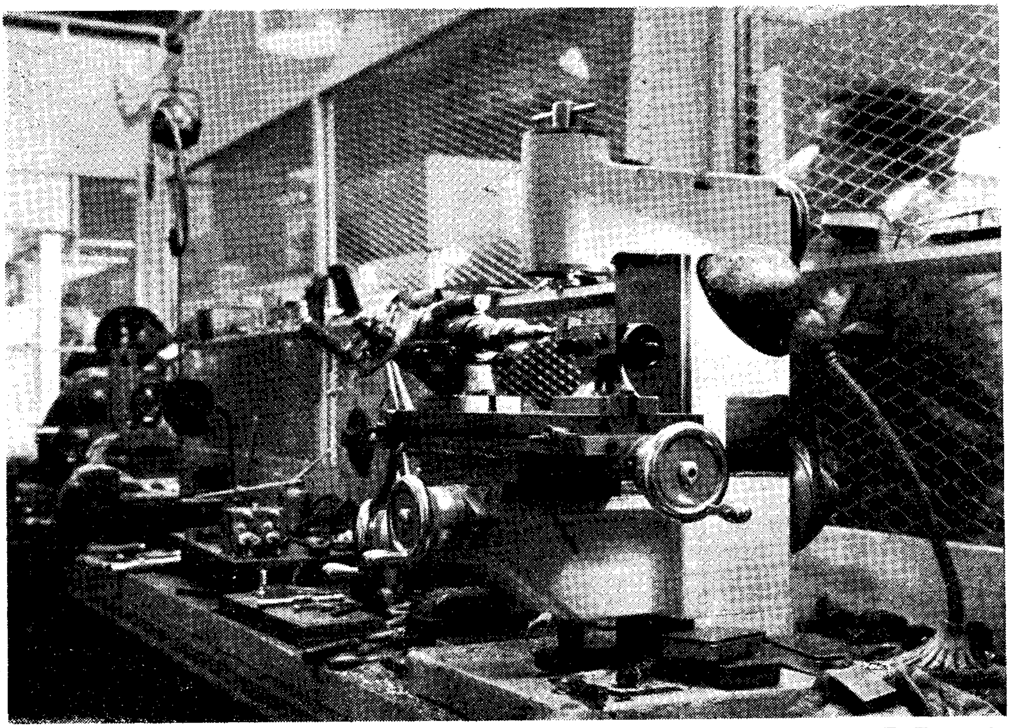


Photo by] [*G. F. Tonnstein*

Photograph No. 1. Mr. B. R. Jenner's vertical milling machine set up for one of its many versatile jobs

I will start right away on the primary problems of workshop equipment, stand layout, staffing, and all the trimmings.

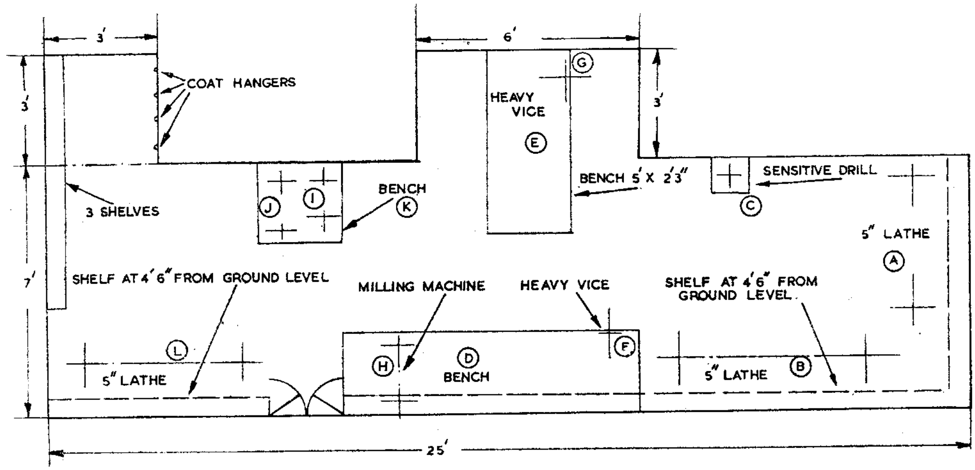
The 5-in. gauge locomotive chosen for this effort was of the "Maid of Kent" 4-4-0 express type, the description of which had just been completed by "L.B.S.C." in THE MODEL ENGINEER. It was, therefore, the "latest in locomotives" and one with which model engineers, anyway, would be familiar. It was agreed

that it should have inside cylinders and Joy valve gear: this cleared up the main outstandings on the constructional side, for the rest would be quite straightforward locomotive building as per articles. The final appearance of the locomotive was not settled—it could pass off as one of several different classes according to cab shape and size, splashers, running boards, chimney, etc. Now for the means of building it.

The first headache (of workshop equipment) was soon solved by the generous offers of the Acorn Machine Tool Co. (1936) Ltd., of Chiswick, Mr. F. W. Bontor (president of the society) and Mr. B. R. Jenner (member of the committee of the society) to loan the society machine tools and valuable equipment to augment its own tools and machines. Other members also came forward with offers to loan small tools and also to bring their own, when working. Hence it turned out that many offers had to be turned down through lack of space on the stand to accommodate them, one of such offers (Acorn Machine Tool Co.) was of an excellent 1 in. floor drilling machine, which would have been of immense value to the hard-worked members who had to be content with a Progress No. 1 bench-type drilling machine from the same firm. Mind you, this latter drilling machine was a real beauty and did all that was asked of it—it is now in a member's workshop following a wild rush to the suppliers by the many members who realised its real value, after giving it the "once over" and working on it.

One of the worst difficulties was expected to be the staffing of the stand. Here again, the main problem was space on the stand to accommodate all those who rallied to the secretary's "not so rosy picture of sweat and toil," so the order was "first come, first served." Extra help, however, was available at most times from the many members "floating about" the exhibition hall. As it happened, some ten of these members were called upon at various times to do jobs ranging from the making of studs and nuts to the fetching of large jugs of tea. In the main, however, only five members worked on the stand, for it was soon found that progress was reduced when more members were involved.

I now come to the layout of the stand, and in order to get the maximum number of machines and equipment installed, coupled with the need to find room for all the operators and assemblers estimated for the job, many hours of sleep were lost and many plans scrapped. A space 25 ft. by 7 ft. (plus extensions to 10 ft.) seems quite big until one starts to put in several lathes, drilling machines, a milling machine and benches, in such positions that visitors could see reasonably well just what was going on, and still allow space for operations and a means of access to the stand.



The included plan shows the eventual layout, and is as follows:—

A 5-in. Acorntools lathe (marked (*A*) on plan); a 5-in. Halifax lathe (*B*), both machines having full equipment including (each), two chucks, boring table, collets (full range), tool holders, etc., while the Halifax lathe also has a milling attachment. Both machines supplied complete with stands and chip trays. A Selector double-ended grinder (*I*) and a Progress No. 1 table model drilling machine (*J*) complete with chucks and guards. Although only the sensitive drilling machine (*C*) is indicated on the plan, Mr. F. W. Bontor also loaned welding equipment, surface plates, and an immense number of valuable fine tools, gauges, etc., without which the story of this venture might well have been very much different.

The milling machine (*H*) (see also photo No. 1) was designed, built and loaned by Mr. B. R. Jenner, and, with all its associated equipment, was in constant use and much admired by visitors, especially model engineers who were impressed by its robust construction and obvious ability to do a real sound job. All machine tools were loaned completely motorised.

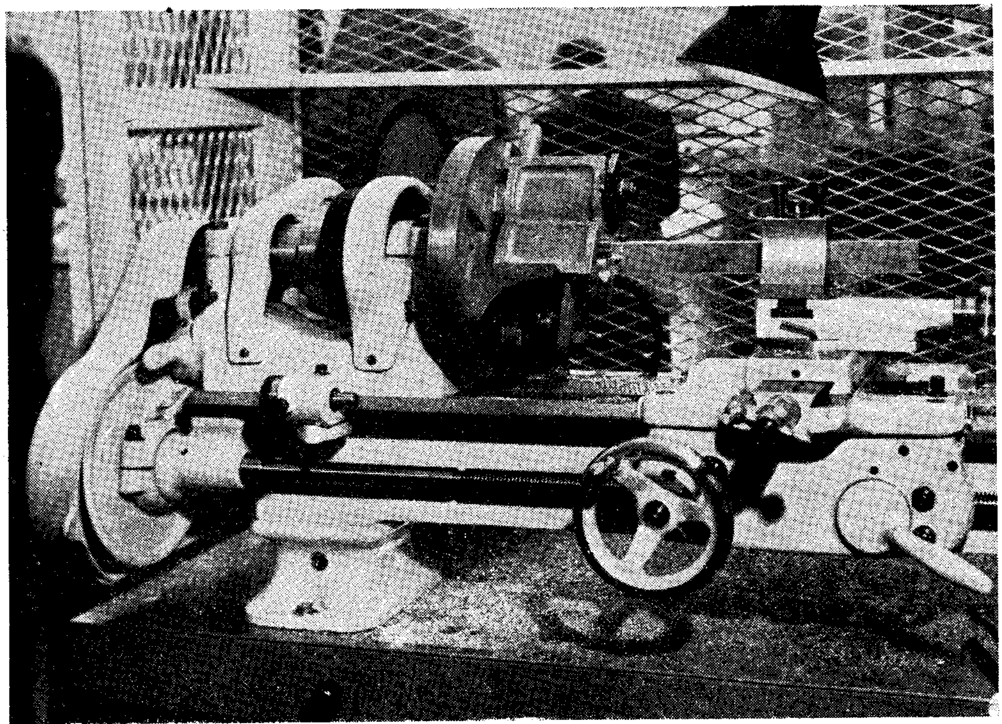
The benches (*D*), (*E*) and (*K*) and the 5-in. Southbend lathe (*L*) (with full equipment) came from the society, whilst the heavy vices (*F* and *G*) were loaned by members.

To all this add the dozens of small tools, the castings for the job (Messrs. Kennion Bros. (Hertford) Ltd.), and all the raw materials, to say nothing of a dozen cups for the much-commented on tea, hanging space for members'

coats, etc., and some idea of the problems involved will be apparent.

A 9 in. wide shelf was provided, as indicated, dotted on plan at 4 ft. 6 in. high, to accommodate small tools and finished parts. This proved to be of great value and is shown in several photographs.

This description would not be complete without mention of the "trimmings"—the dozens of small acknowledgment cards and the main plans, display cards, rag, oil and 101 other items all had to be transported to the hall. Once there, they had to be manhandled into position, fitted and wired up or stowed away for future use. So well did everything fit in, however, that by early evening the stand became a very well-equipped, orderly workshop. Many snags arose, but luck held, and even in the case of bringing in heavy plant, another Malden member



Photograph No. 2. The cylinder block set up on the society's South Bend lathe for boring

announcement of the work being built on the stand (in 5-in. letters) well displayed on the rear wall (visitors will remember this), all of which were the work of 18-year-old Philip Alford who, with his twin brother Derek, did much work on the locomotive chassis as well.

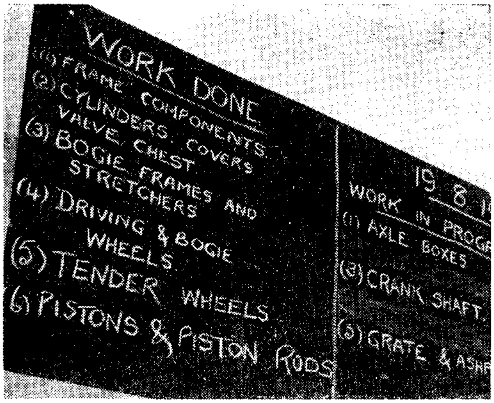
The workshop was under the control of Mr. R. C. Marshall (of "Mustang" fame) and Mr. C. L. Newman, who both did a grand job, not only in fitting in the jobs to be done, arranging for staff and organising the whole "bag of tricks," but also in setting an example to others by their enthusiasm, capacity to to the almost impossible, and skill of workmanship.

That some 500 parts were made in the ten days plus the assembly of the completed chassis, the latter, a far bigger job than words can describe, tells far more of this effort than can be put into an article of this size.

Final Set-up and Commencement

The day before the opening of the Exhibition saw much activity; machines, benches, tools, (Mr. E. J. Baughen) came to the assistance with his traction engine trailing truck, which saved long walks with heavy awkward loads.

Let me recap. on the machinery and equipment available, three 5-in. lathes with full equipment, a heavy milling machine, two drilling machines, a grinder, welding equipment and benches, together with a vast quantity of fine tools, gauges and hand tools, raw material and so forth. Several of the machine tools needed running in before they could be used and this was put in hand as soon as possible. Equipment likely to be used on the first day was put out ready for such use; other equipment was checked to ensure safe arrival and continued accuracy, and stowed away so as not to be a hindrance. It was whilst dealing with these important features that a check-up was made on the Progress No. 1 drill, and satisfaction was expressed at the high degree of accuracy of this standard production job—as I have mentioned before, it is now in a member's home workshop. The lathes too, were excellent machines.



Photograph No. 3. The "Progress Board" on Friday afternoon

The quantity of materials needed for a job of this nature is huge, and by the time the castings for the job were collected from Messrs. Kennion's stand, the whole workshop looked an impressive sight.

The last hour or so of this "setting up" day was spent in installing bench and machine lights, laying out of pipes and tobacco and doing the many jobs which seem to delight in popping up every few minutes.

The great day eventually came and a final check up was made to ensure a good getaway, and so it was that a few minutes after the opening speeches had been made that the motors were switched on, and, as one Malden member announced, "Let battle commence."

The First Three Days

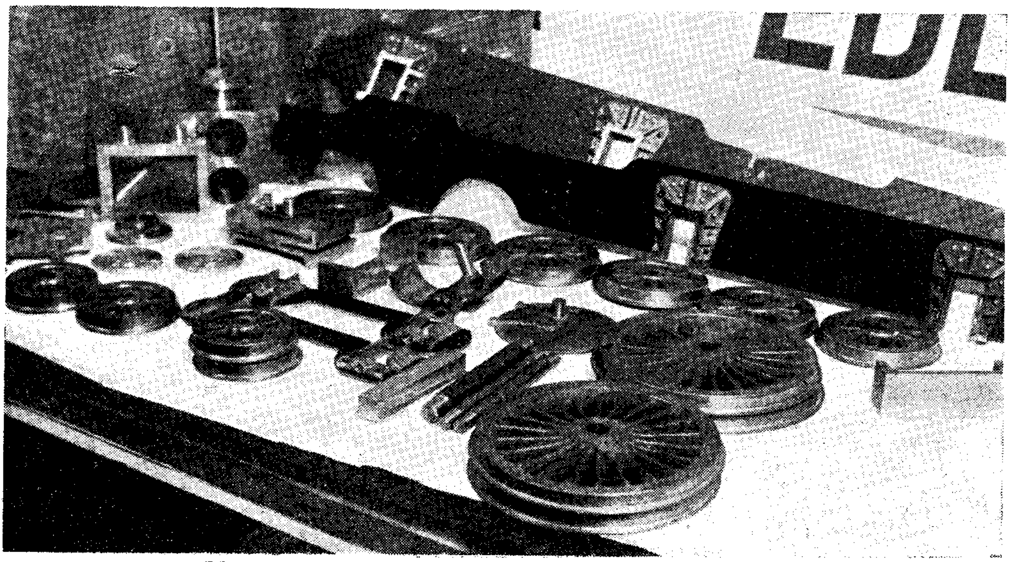
I really *do* think that the hero of the first day was Cyril Newman, for he not only marked, cut out and drilled the main frames, but he also fitted the horn blocks—the "Maid of Kent" frames are not of the easiest by any means. Perhaps the most expressive observation on Cyril's efforts was made to me the next day by an exhibition officer : "You lot of rotten blighters, fancy letting a poor chap sweat his guts out like that." My reply that I should have liked to have seen anyone try to stop him whilst he was in such mood, happily solved the problem ; I really meant my remarks. For I can still picture Cyril, sweat flowing from every pore, as, armed with a hacksaw and a genuine murderous glint in his eye, he cut through the steel plates literally as though they were made of butter. Please don't think that the others just looked on, far from it. Everyone made a supreme effort to make a real sound getaway, and they succeeded magnificently.

The cylinder block was machined and bored, and a fine job Dick Marshall made of it, too. The block, set up in a lathe with an "on site" made boring bar can be seen in Photograph No. 2 (quite a number of jigs and special tools, etc. were made on the stand for the job during the exhibition.)

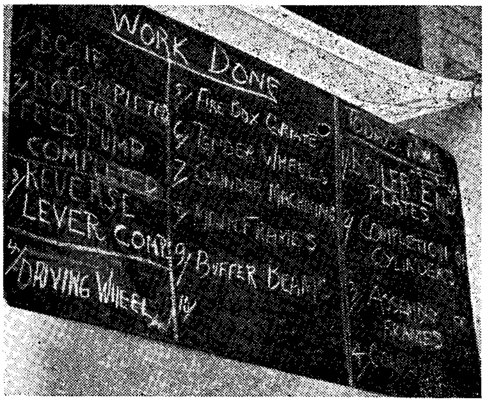
All the driving and bogie wheels for the locomotive were turned and centres bored by Mr. J. G. Wells. The bogie frames were marked and cut out and drilled, and several small parts either turned, cleaned up or milled during the first day.

On the second day (Thursday), the steam chest and cylinder covers, all the axles (except crankshaft) were completed ; work commenced on the boiler feed pump, motion plate and smokebox door.

By Friday evening the progress board looked quite impressive and just before 9.0 p.m. the bogie axle boxes, grate and ashpan, smoke



Photograph No. 4. A collection of machined parts on Friday



Photograph No. 5. The "Progress Board" on Monday, August 22nd

box ring and the buffer beams were all complete. Photograph No. 3 shows the progress board as it appeared at about 5.0 p.m. on the Friday, August 19th, and Photograph No. 4 shows some of the actual work done. The progress at this stage was ahead of time and several items of materials held over until needed were hurriedly sent for. The advantage of having several suppliers close at hand was seized upon and Messrs. Kennion Bros. (Hertford) Ltd., Dick Simmonds and Co., and Buck and Ryan all helped with materials, tools and castings; in fact, they all gave wonderful service and if items needed were not to hand they either sent for them or delivered the next day. This co-operation was much appreciated and saved a lot of valuable time.

From the progress chart kept, I append herewith details of the first three days' progress. The "man-hours *worked*" figures are approximate only, but every care was taken at the time to ensure accuracy and fairness, especially on the calculation of hours lost over meals, etc., which have been deducted.

Wednesday:

1. *Cylinder Block*—machined and bored.
2. *Driving Wheels*—turned and centres bored.
3. *Bogie Wheels*—turned and centres bored.
4. *Main Frames*—marked and cut out, drilled, cleaned up. *Horn Blocks*—machined and fitted.
5. *Bogie Frames*—marked and cut out, drilled and cleaned up.

Man-hours worked—36.

Thursday:

1. *Steam Chest* and all *Cylinder Covers*—completed.
2. *Driving Wheels*—completed.
3. *All Axles* (except crankshaft)—completed.
4. *Boiler Feed Pump*—main casting machined.
5. *Motion Plate*—machined.
6. *Smoke Box Door*—part machined.

Man-hours worked—41.

Friday:

1. *Steam Chest and Pistons*—completed.
2. *Bogie Wheels*—completed.
3. *Tender Wheels*—completed.
4. *Boiler Feed Pump*—continued.
5. *Main Frames, Buffer Beams*—cut and slotted.
6. *Crankshaft*—commenced.
7. *Fire Box Grate*—completed.
8. *Smokebox Door and Ring*—machined.
9. *Barrel*—turned to size.

Man-hours worked—34.

Saturday and Monday

Although the progress board to Monday the 22nd looks impressive enough (Photograph No. 5), the amount of work done was not up to schedule and the reason for this was due to having too many people working (or trying to) on the stand on the Saturday. Nevertheless, the ports in the cylinders were milled out, the reverse lever completed, main frame stretchers milled and all parts of the crankshaft completed. All parts of the bogie and boiler feed pump were completed and assembled, work was commenced on the tender frames, axleboxes, etc. and the eccentrics.

(*To be continued*)

For the Bookshelf

Flash Steam by Edgar T. Westbury. (London: Percival Marshall & Co. Ltd.) Price 3s. 6d.

The model engineer, or for that matter, the "full sized" engineer, can always be sure, on reading an article or text-book by Edgar T. Westbury, of having presented to him a wealth of knowledge, expounded in clear and lucid manner and obviously the carefully prepared product of a keen and analytical brain. Mr. Westbury's latest book on flash steam is no exception to this rule and though it is apparently largely a compilation of previously published articles by him, it is, nevertheless, a welcome and nuch-needed publication. Much of the data appertaining to the generation and use of flash steam, has in the past, been veiled in obscurity and this text-book should go a long way towards helping both the tyro and the expert who are interested in this method of steam generation.

The book deals with the subject in a very complete and comprehensive manner, not only from the historical angle, but also in relation to its use in power boats, locomotives and cars.

Chapters are devoted to types of generators, firing methods, types of engines, water and fuel feed arrangements and so on, and an interesting appendix gives details of several of the more successful flash steam plants.

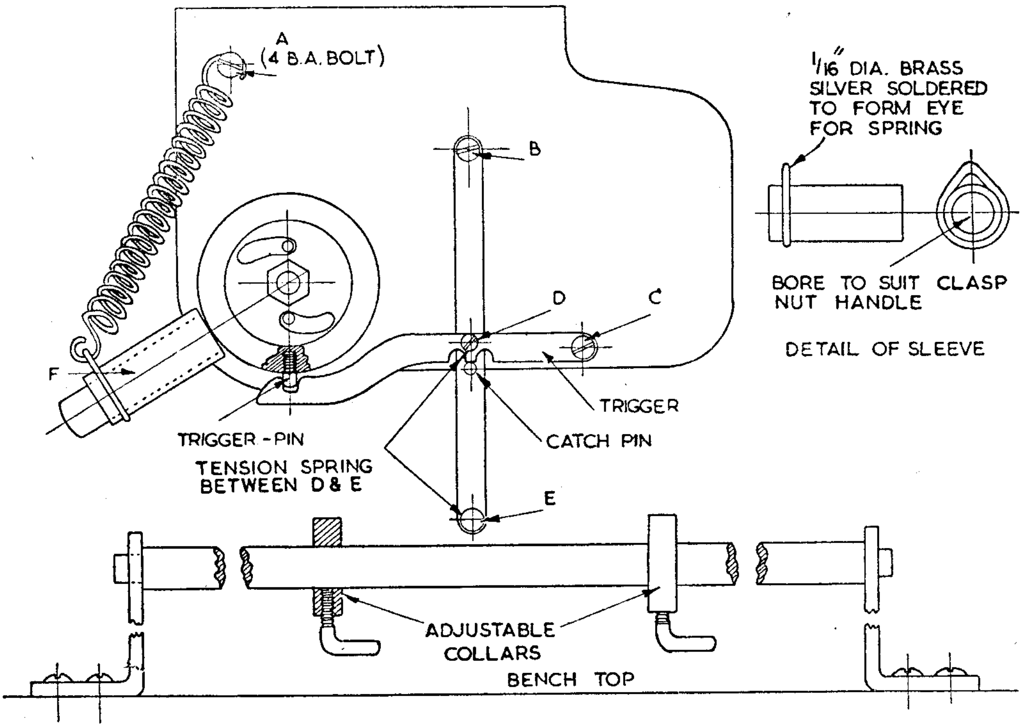
Many of the excellent drawings illustrating the text are from the author's drawing-board, as are several of the designs for engines, generators and accessories.

Definitely a book that should appeal to anyone interested in steam engines of any kind.

An Automatic Disengaging Device for Leadscrew

by D. J. Mather

THE Heath Robinson device shown in the drawing was constructed to cope with screw-cutting an inside thread on a small i.c. engine cylinder. Visual operation was impossible, the bore being small, and as the clearance between the end of the thread and the top of the cylinder was also very small, some form of automatic disengaging was essential. At the same time it was not considered desirable to carry out any major operation on the lathe (in this case a Myford M.L.4).



The sketch is approximately to scale, but as alterations to the layout would have to be made to suit different lathes, no sizes are given.

To start operations, engage the clasp-nut with the leadscrew and mark on the underside of the wheel the point which is vertical to the centre. Remove the lever and where marked tap $\frac{1}{8}$ in. Whitworth in the centre of the rim of the wheel for a depth of $\frac{3}{16}$ in. and fit the trigger-pin ($\frac{1}{8}$ in. diameter silver-steel) making it protrude about $\frac{1}{8}$ in. Replace the clasp-nut lever making sure it works very freely.

The trigger can then be made from $\frac{1}{4}$-in. square mild-steel. The groove to engage the trigger-pin should be slightly rounded at the top to allow the pin to slide out easily when the trigger is depressed.

The position of the trigger arm should be decided upon so that it does not foul any part of the lathe apron. This, of course, decides the position of the two grooves to accommodate the catch pin, and they should be made slightly less than $\frac{1}{8}$ in. apart. The pivot, *C*, is a 4-B.A. bolt screwed into the lathe apron and carries a sleeve to position the trigger a full $\frac{1}{4}$ in. from the apron.

The trigger arm is also $\frac{1}{4}$ in. square mild-steel, free to pivot at point *B*. The catch pin is a piece of $\frac{1}{8}$-in. diameter silver-steel press-fitted and placed so that when the arm is vertical the pin lies between the grooves of the trigger, the trigger holding the clasp-nut engaged as shown. A slight movement to left or right of the trigger-arm allows the trigger to fall, releasing the clasp-nut lever, which flies up under the action of the spring.

A spring is also fitted between point *D* (a 6-B.A. screw) on the trigger and *E*, which is a length of $\frac{3}{16}$-in. diameter silver-steel press-fitted, which protrudes $\frac{1}{2}$ in. in front of the arm and 1 in. to

(*Continued on page* 663)

A Heavy Duty Sensitive Drilling Machine

by F. Butler

AFTER an unsuccessful search for a second-hand motorised drilling machine at the right price and with the desired performance, it was eventually decided that the best plan would be to procure some of the largest components from a machine-tool dealer and then to build a machine with these as a basis. A ½-h.p. three-phase induction motor was already on hand and a 6-in. centre lathe was available on which to do the machining.

A visit was paid to the largest used machine-tool factors in the district, where an attempt was made to locate some promising material. The most likely source of useful parts appeared to be a large 3-spindle sensitive drill which was scheduled for scrap. One of the three columns appeared to be quite sound, although the machine had been badly smashed in most other respects. This component was purchased, and a further search unearthed a machined T-slotted table upon which the vertical column could be fitted. A machine vice, a pair of 3-step Vee-pulleys and a few small tools completed the list of requirements.

Many hours were then spent cleaning and dismantling everything and deciding on a suitable conversion scheme. At first, this seemed to present some difficulties, but in the end a fairly simple plan was evolved.

The motor speed was 1,440 r.p.m. and the available ratios of the pulley diameters, using direct drive between motor and drill spindle, gave drill speeds of 720, 1,440 and 2,880 r.p.m.

Using high-speed steel drills, the lowest speed gives the machine a rated capacity of ½ in. when working on cast-iron or mild-steel. The highest speed is sufficient to operate a $\frac{1}{16}$-in. drill under the proper conditions. This range seemed wide enough to meet most requirements and so it was decided to leave out any back-gear arrangements, which in any case would have involved a tremendous amount of additional work.

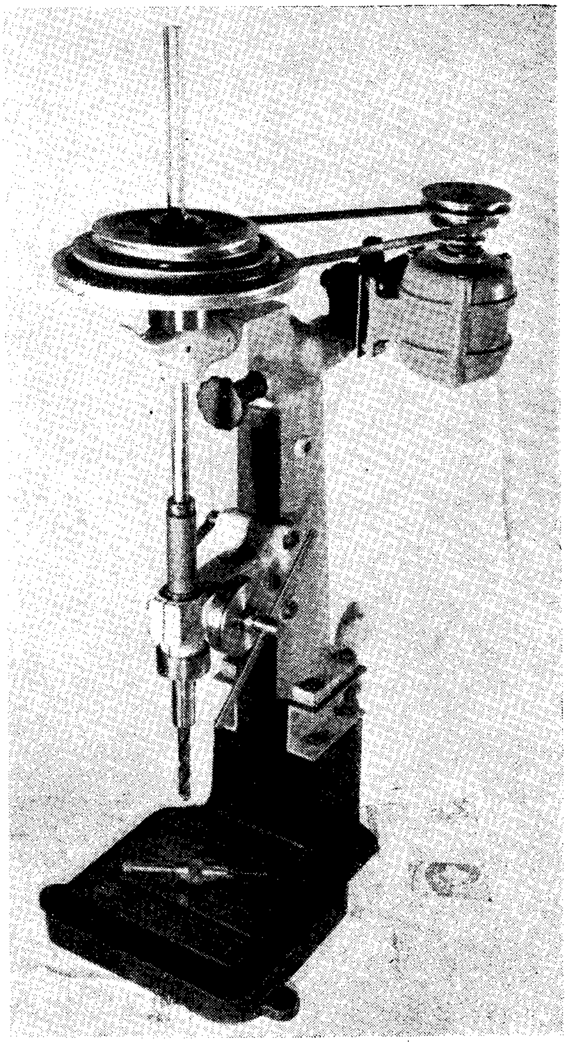


Photo by] [*S. E. Janes*

Fig. 1. *The complete drilling machine*

The photograph, Fig. 1, shows the general arrangement, and is almost self-explanatory. It will be seen that the drill column is attached to the pedestal base through the medium of two short machined lengths of channel steel. These gave about 4 in. extra head-room and were, in any event, required because the column and pedestal bolt-holes were spaced differently.

The motor is fitted to an outrigger arm at the rear of the machine. This was originally intended to carry jockey pulleys, used with a flat belt drive. An existing feed-screw provided for belt-tensioning purposes was also retained. It now permits changing the speeds without springing the Vee-belt over the pulley flanges.

Some ingenuity was required to fit the motor neatly to the existing bracket, which was of very awkward shape. Careful measurements were also

required to ensure the exact alignment of the two drive pulleys. Eventually, the whole job was rigidly built, using only a piece of flat mild-steel plate, a 6-in. × $\frac{5}{8}$-in. bolt and two distance-pieces made from round mild-steel bar.

The photograph, Fig. 2, shows the motor mounting and the belt-tensioning arrangements.

The driving-head assembly is shown in Fig. 3. Almost every part of this, except the ball-races, but most of the items required only plain turning and none of them calls for special mention.

The writer is indebted to two of his friends for help in brazing and welding the component shown in Fig. 4 and for milling the keyways in the same item. The remainder of the work was carried out with the usual model engineer's facilities.

The performance of the machine proved to

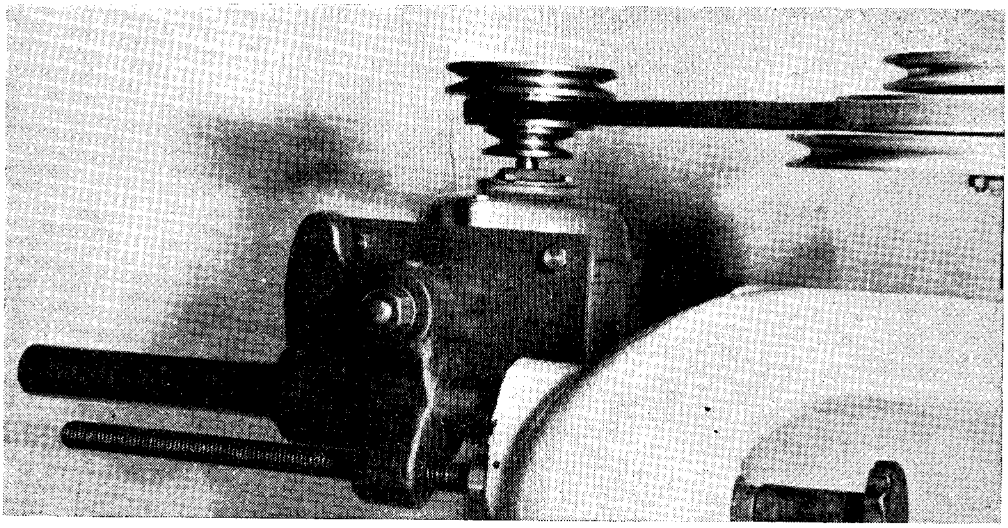


Photo by] [*S. E. Janes*

Fig. 2. Motor-mounting and belt-tension arrangement

had to be specially made. The Vee-pulley *V* is bored out to receive a bell-shaped member *A*, shown in greater detail in Fig. 4. This was fabricated by welding and brazing, using oddments of mild-steel plate, tube, and round bar. It is pressed and keyed into the pulley bore. Two ball-races are fitted to a short stub *B*, which is pressed into a bored hole at the head of the drill column. Extreme care was taken over the machining of these components, and working to very close limits was involved.

The wider portion of the spindle drive member shown in Fig. 4 is bored out to take the outer races of the two ball-bearings which are carried on the fixed stub *B*, and it will be seen that the Vee-pulley is thus free to revolve on these two races, which, at the same time, serve to take the belt tension. The drill spindle passes centrally through the head assembly, being a sliding fit in *A*, while *B* is bored out $\frac{1}{16}$ in. larger in diameter than the spindle. Drive is transmitted from the pulley to the drill spindle by two feather keys which engage two keyways milled lengthwise down opposite sides of the spindle. The drill spindle thus slides in *A* and revolves with it, but is relieved of all side thrust from the belt. Drill feed is applied from a hand lever to the drilling-head by means of a rack and pinion, while a clock-spring device retracts the head after use.

A good deal of detail work was involved apart from the main operations already described, be much better than had been anticipated, and is, in fact, only limited by the motor power, while the cost, exluding that of the motor, was less than a tenth of that of a similar new machine. The maximum height from the table to the bottom of the drill spindle is 18 in., and the machine will drill to the centre of a 16 in. circle. The use of heavy castings ensures great rigidity of construction, which is not commonly found in pillar drills of similar nominal capacity. Even at the highest speeds, there is no troublesome vibration or noise, except that which seems unavoidable when ball-bearings are used.

The leading dimensions of the machine are given below :—

Overall height, 4 ft. ; Cast-iron base (overall), 1 ft. 8 in. square ; Machined surface of base, 10 in. × 12 in. ; Spindle length, 3 ft. 4 in. ; Spindle diameter (minimum), $\frac{7}{8}$ in. ; Drill socket, No. 2 Morse taper ; Length of rack feed, 8 in. ; Largest pulley diameter, 5 in. ; Vee-belt size, Fenner A.46 ; Total weight (estimated), $1\frac{1}{2}$ cwt.

In conclusion, a few facts about modern drilling practice may be noted. Using small high-speed drills (up to $\frac{1}{4}$-in.), it is possible greatly to exceed the normal recommended speeds when drilling relatively thin sections, provided that a plentiful supply of coolant is used. This is because the drill penetrates the stock in such a short time that overheating cannot occur.

With all drills, the essential point is to sustain

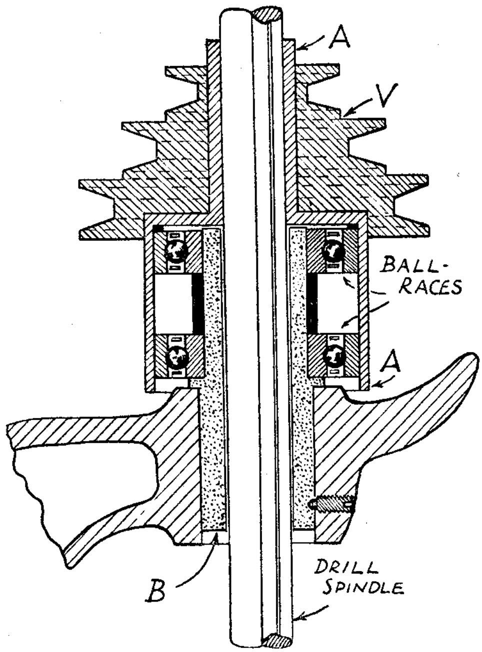


Fig. 3. *Drill drive assembly*

the feed so as to avoid rubbing and abrasion of the drill tip. The feed must be slackened as soon as the drill point breaks through the work.

Using a ¼-in. drill in the above machine, and working on mild-steel, a feed rate of 6 in. per minute can be employed at 1,440 r.p.m. Lack of power limits the performance with ½-in. drills, but even in this case a hole 1 in. deep can be drilled from the solid in about 50 seconds. Larger holes are produced in two operations, first using a small pilot drill. Used in this way, the absolute maximum capacity of the machine, when drilling steel, is ¾ in.

It will be noticed that the driven pulleys shown in the photographs differ in size from those on the drawing in Fig. 3. The smaller size steps give drill speeds about the same as have been standardised on some commercial machines of ½-in. capacity. To deal with tapping and heavy counterboring operations, a lower spindle speed is necessary. This is also required for honing and lapping. It was to meet these requirements that the alternative larger pulleys were fitted. They are standard aluminium alloy wheels, with diameters of 8, 10 and 12 in. respectively,

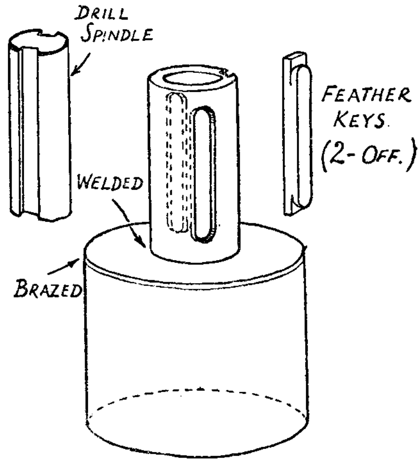


Fig .4. *Spindle drive sleeve*

providing spindle speeds of 250, 450 and 800 r.p.m., using a Fenner belt, size A-55. At the lowest speed, 1 in. holes can be drilled in mild-steel, provided the feed is not forced.

An Automatic Disengaging Device for Leadscrew

(*Continued from page* 660)

the rear. This rear projection catches with either of the two adjustable collars on the length of ⅜-in. diameter mild-steel which can be attached to the bench by means of a bracket at each end. It should clear the rod by about ⅛ in.

The clasp-nut actuating spring is attached to the handle by means of an eye made from $\frac{1}{16}$ in. diameter brass rod silver-soldered to a small length of tube which slides over the handle. This was done for easy removal and also to increase the leverage.

Both springs should be strong, but it may be a matter of experiment to get the correct tension for both.

To operate the device, place the lathe tool at the point where it is to disengage from the work, engage the clasp-nut, making sure that the lead-screw backlash has been taken up and slide the required (left or right) collar up until it triggers off. Lock the collar in that position and it is all set.

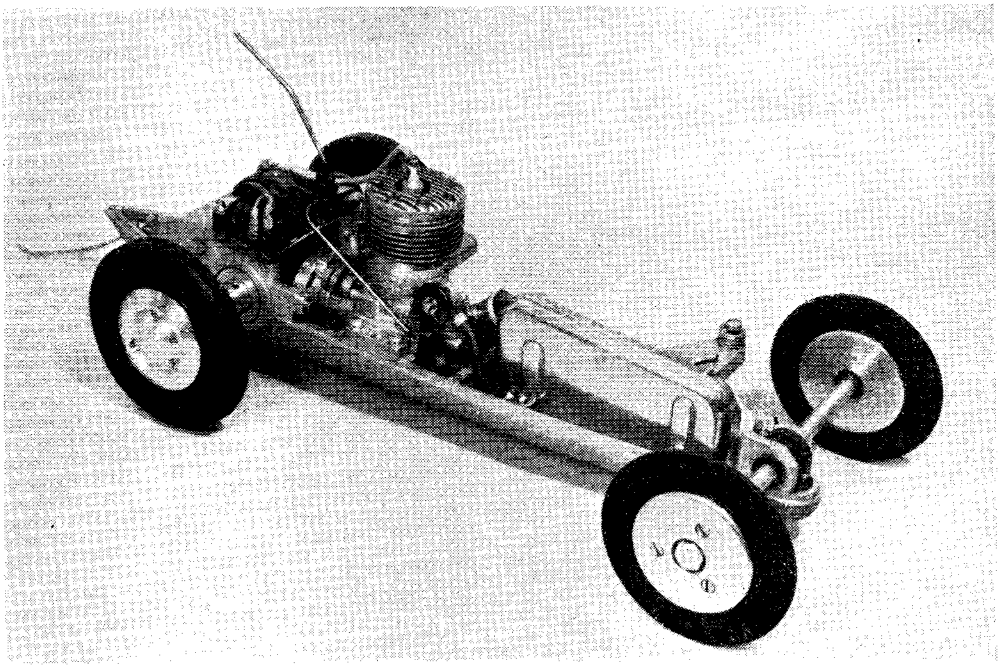
In practice the device has been found to work perfectly, except when taking an exceptionally heavy cut, when the pressure on the trigger-pin is sufficient to overcome the strength of the spring.

However, if it is desired to use it under these conditions, one can press on the trigger with one finger which is sufficient to make it operate at the correct point.

One objection to the device may be that it makes a decided bang when it operates, but it does provide audible warning that the lathe has ceased to do any useful work in spite of the motor still being switched on.

Race-car Notes and Tips from the U.S.A.

by Howard W. Frank



The " works " of the Dooling Arrow, famous American miniature racer, which has achieved much popularity in this country

AT the mid-winter AMRCA race held on February 25th and 26th at Jacksonville, Florida, the spur-gear record was broken by Jack Ray with a speed of 142.85 m.p.h. The prototype record was also broken by Wayne Doerstler at 142.63 m.p.h. Both records were established with Dooling powered cars. The track surface was extremely well suited to high speeds, having been treated with either hydrochloric acid or nitric acid for about ten minutes to etch the concrete surface. The track was then neutralised with soda ash and water.

During the 1949 racing season it was definitely felt that the chrome plating of cylinder liners on Dooling engines meant 6 to 8 more miles per hour. The ignition timing for 10-c.c. motors has now been increased to 0.198 in.-0.205 in. before T.D.C. Carburettors are now being rebored 0.020 in.-0.040 in. oversize from the standard $\frac{3}{8}$ in. bore. Compression ratio has been increased by removing 0.010 in. off the cylinder-head.

In the 5-c.c. class, Dooling has announced a new engine which develops $\frac{3}{4}$ horsepower at 17,500 r.p.m. The engine has a bore of 0.800 in. and stroke of 0.594 in. No official tests have been made with this engine in race cars as yet.

Hornet expects to produce a race car by June which will have a new 0.199 cu. in. engine—in tests, the first few cars did well over 90 m.p.h. A rumour has been going around that Hornet is also working on a new 10-c.c. engine, possibly with a fuel injection system.

The McCoy series " 20 " engine now has an improved light-weight piston better suited to the hot fuels being used in America.

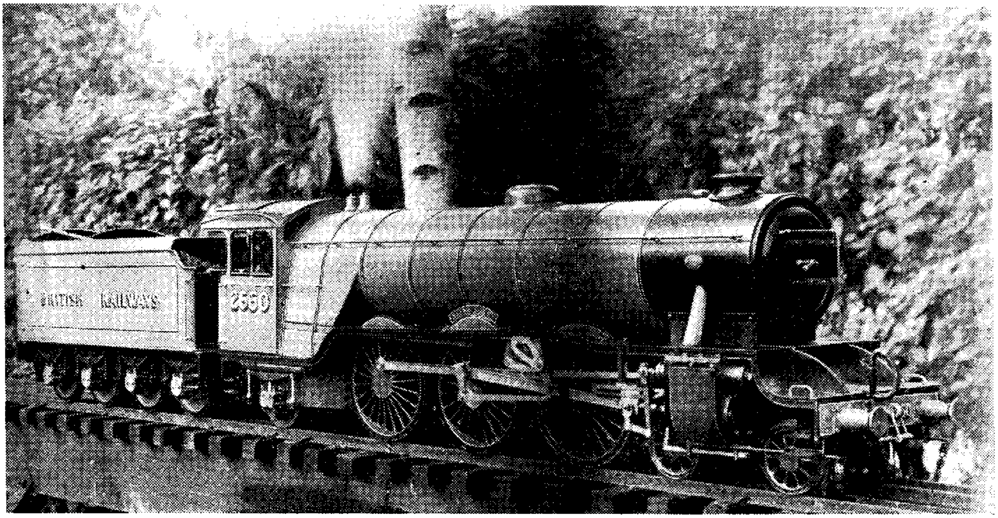
Regarding fuels, most of the record-breaking cars during 1949 used as much as 50 per cent. nitromethane. A top speed fuel which is " fairly safe " is 25 per cent. castor oil, 35 per cent. nitromethane, 10 per cent. nitrobenzene (oil of merbine), and 30 per cent. methanol. An attempt is being made to find a synthetic oil to take the place of castor which will not form gum and sludge. The use of 5 per cent. so-called additive oils for diesel engines has been tried with much success, which means reducing the castor to 20 per cent. of the mixture.

Prototype cars in the upper speed bracket are being fitted with special bevel gears with a ratio of 1.84, and use hard 4 in. tyres which will expand to $4\frac{1}{4}$ in. at 10,000 r.p.m. " Frying pan handles " are now replacing the wire bridle, which has resulted in better balance and traction of the cars.

Speeds for 1950 will be still higher, and so as not to discourage the slower operators who are unable to afford the expensive custom speed equipment produced by a few specialists, our rules are being modified to allow the slower fellows a chance in competitive race meets.

A "Bonny" Job! by "L.B.S.C."

THE boys up North surely know how to do it, as the reproduced pictures will show. This engine was by way of being a long job; not the builder's fault, I hasten to add, the delay being mainly due to a certain late and unlamented party who was known as Adolf the Unworthy. She is, as you can see, a one-sixteenth edition of some of the components for the boiler, which is made as per my usual practice, and steams like a witch. He also did the painting and lining. Incidentally, although I have already seen plenty of pictures of small engines with "British Railways" on their tenders and tanks, up to the time of writing I haven't seen one with the lion and



Mr. C. Lampitt's "Blink Bonny"

the first lot of Gresley Pacifics, and was started before the war. At that time, the only available drawings were a set got out by a designer who has also departed hence; consequently, the engine only has two cylinders, and some of her components don't agree with modern practice. However, the builder, Charlie Lampitt, of Leeds, got started on the job, and made steady progress until the war stopped him. After hostilities were over, he got busy once more, but this time with a difference. Your humble servant had started to describe a L.N.E.R. Pacific, and our worthy friend took the notes as a guide, with the result that although externally she follows the lines of the original design, the things that matter are all in accordance with these notes, and the result is satisfactory, "with knobs on" as the kiddies would probably say.

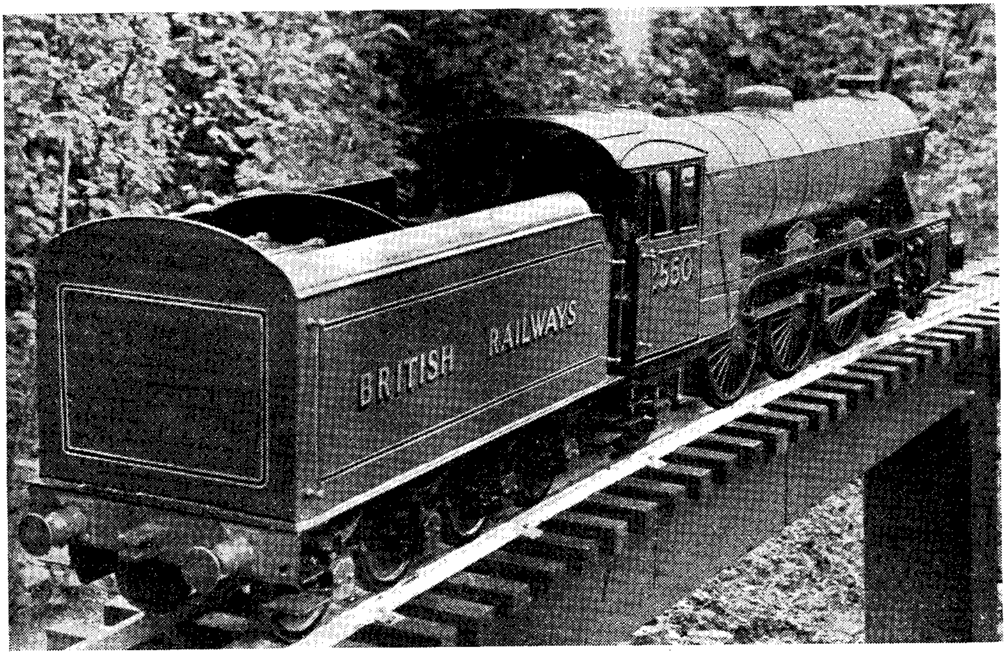
There is no need to describe the engine in detail, as the photographs show practically everything of importance; and the machining, fitting, and other work entailed, were done in the manner usually observed among painstaking and conscientious locomotive builders. Charlie was lucky in getting a little assistance in finishing her off, from another brother of our craft who is too shy to have his moniker in print, though up at Leeds they all know him well—'nuff sed! He made wheel on it. I've a sneaking regard for that poor old animal, he is so typical of the British people, looks as though a jolly good feed would do him a world of good, yet he always keeps his tail up and always faces toward the front of the engine.

Blink Bonny collected her racehorse name by virtue of really being bonny, and she certainly "makes them blink." She is a first-class worker, no trouble to keep in steam for hours at a stretch when necessary, as when working on an exhibition track hauling heavy loads. A typical example of what she can do, was shown on August 24th last, at the Leeds City Police Gala, on their sports ground, the line being the Leeds Societies' Miniature Railway. She was lit up at 2.30 p.m., and was in steam until 8.15 p.m., running continuously. She carried 843 passengers all told, most of them kiddies, but for a test she hauled six of the heaviest Leeds bobbies present at the gala, and without the least distress. Among the drivers were the Lord Mayor of Leeds, and the Chief Constable. The above explains the temporary coupling-fork in the tender buffer beam. The ordinary coupling isn't strong enough to stand the racket, so the temporary one is put in for heavy hauling, and her owner forgot to take it off before she was photographed. The engine is certainly a credit to her builder and his friend.

He Was a *Craftsman!*

May I add my humble tribute to what has already been written about the late Dr. John Bradbury Winter, as he was my great friend, and I was in correspondence with him to the last. He used to visit me occasionally, when living at Sheen, and when he and Dr. Hovenden and your humble servant started talking about the old L.B. & S.C.R., it was a non-stop performance, and a job to know when to leave off! I'll always recollect one summer afternoon, when Drs. Winter and Hovenden, and Cecil Purdey, of sporting-gun fame—now, alas! all on the other side of the Great Divide—were running one of my engines. Dr. Hovenden was driving, the other two on separate cars. An up goods train, hauled by an old Brighton "Vulcan" running tender first, stopped by signal right opposite my little railway; and the driver, seeing the little engine sailing merrily along with its live load, blew his whistle and waved. Dr. Hovenden blew the little engine's whistle in reply, and waved so vigorously that he lost his balance, got the whole train off the road, and nearly put his passengers in the ditch, much to the amusement of the full-size crew. When my friend, Rob Morse, lived at Woodmancote, Sussex, the two locomotive medicos used to go down there occasionally to drive his 9½-in. gauge Stroudley tank engine *Ranmore*; and, in the words of a well-known radio comedian, "a jolly good time was had by all."

I put the worthy Doctor in communication with Al Milburn, who is cutting his 3½-in. gauge Atlantic engine out of the solid, in a manner somewhat similar to the way our late brother built *Como*; Al sent him some photographs, and in one of his letters afterwards, J.B. told me he had spent an exceedingly pleasurable time going over them with a powerful magnifying glass, but could find no fault with the workmanship. Also, he said that he felt a great pride, inasmuch as his own efforts had stimulated another brother of the locomotive craft, to do his best to emulate them; and he meant just that, as those who understood his personal character, would know full well. Praise from Dr. Winter, was praise indeed—he was the one man above all others, fully qualified to give it, by virtue of personal experience. By his passing, the world has lost, not only one of its most expert craftsmen, but a lovable, kindly personality, the like of which is fast disappearing from this benighted planet.

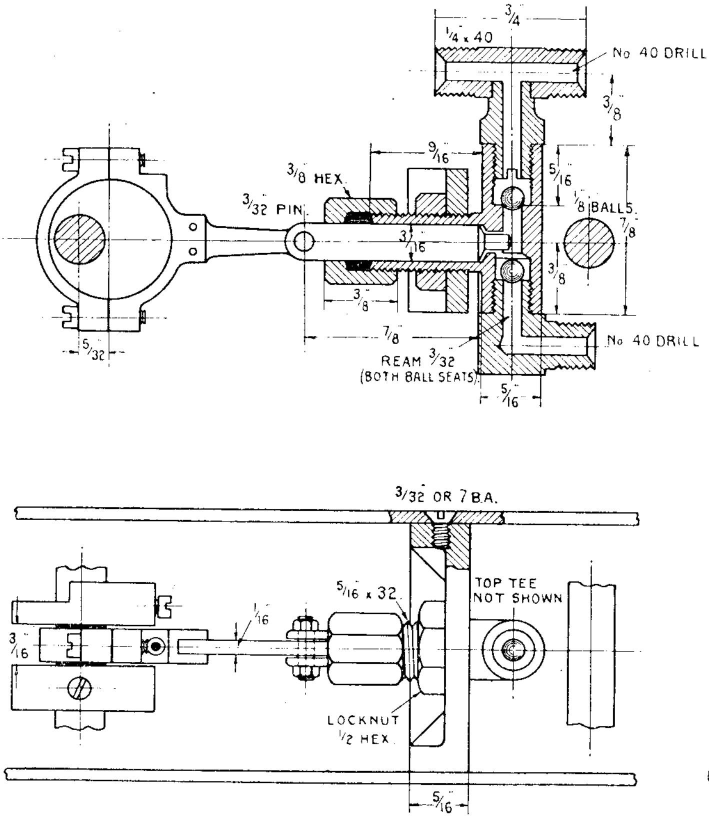


A nice bit of lining and lettering

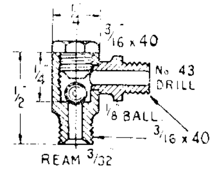
"Diana"—Final Details

The reproduced drawings show a boiler feed pump which is not only suitable for *Diana*, but for any gauge "1" locomotive which has room enough for it between two of the axles. There is no need to describe it in full detail, as the construction is precisely the same as I described very minutely for *Tich*; and incidentally, I might remind new readers that I started giving *fully-detailed* instructions, even down to drill sizes, for locomotive-building, way back in 1924. Briefly, the pump is a reduced version of what one might call my "standard" type of pump; tried, tested, not found wanting in any respect whatever, and entirely free from complication of any sort.

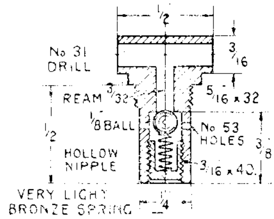
It also contains the absolute minimum number of parts. The body can be made either from a casting, or from $\frac{5}{16}$-in. round bronze or gunmetal rod. The casting is machined up as described for *Tich*. If made from rod, part off a $\frac{7}{8}$-in. length, and drill, ream and tap it to form the valve-box, just the same as the casting. Then at $\frac{3}{8}$ in. from the suction end, drill a $\frac{3}{16}$-in. hole in the side, and fit off the shoulder to the same angle as the point of the drill used for drilling the pump barrel. In case anybody reading this, hasn't seen my description of the pump for *Tich*, and wonders what this pip is for (sometimes it is called a "pintle") it enters the hole at the extreme end of the pump barrel at the end of the stroke, and expels any air that may have become trapped in



Details of pump for "Diana"



Special small side clack



Simple top feed fitting

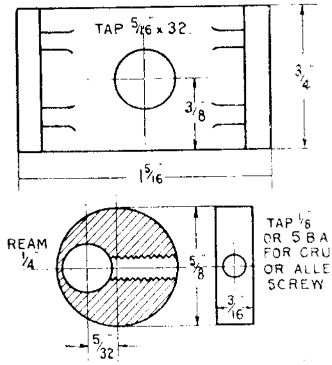
a separate barrel into it, the barrel being also made from $\frac{5}{16}$-in. rod. Chuck a piece truly in the three-jaw; face, centre, and drill down about $\frac{3}{4}$ in. depth with a 7/64-in. drill. Screw $\frac{1}{2}$ in. of the outside with a $\frac{5}{16}$-in. $\times$ 32 die in the tailstock holder. Open out to $\frac{9}{16}$ in. depth with $\frac{3}{16}$-in. drill; part off at $\frac{11}{16}$ in. from the end. Reverse in chuck, and turn down $\frac{1}{8}$ in. of the end, to a tight fit in the hole in the side of the valve-box; squeeze it in, and silver-solder it. The valve balls, top and bottom caps, and gland nut are made and fitted as described for *Tich*; don't forget to nick the bottom ball chamber under the barrel, so that the ball cannot block the hole when it lifts, preventing water entering the barrel.

The ram is a piece of $\frac{3}{16}$-in. round rustless steel or hard-drawn bronze, $1\frac{3}{16}$ in. overall length. Chuck truly in three-jaw, and turn down a full $\frac{1}{8}$ in. of one end, to 3/32 in. diameter, bevelling the pump. I call it the "anti-airlock pin." Note, *it is only needed when the hole at the end of the barrel is smaller than the ram.* If the $\frac{3}{16}$-in. bore of the barrel were continued right into the space between the valves, spreading them much farther apart, the anti-airlock pin would not be needed, as the pump ram itself would be arranged to go as far as the centre-line of the valve-box at the extreme inward end of the stroke, and would thus expel any air; yet some good folk insist on adding the pip in a full-bore barrel, probably because they imagine it is specified in my pumps for some reason that I haven't explained, and the pump might fail without it!

The outer end of the ram is slotted and cross-drilled, as per *Tich* instructions, ditto the eccentric-strap and rod; but as the eccentric has to fit in the space between the two stop-collars, and this is only $\frac{3}{16}$ in. wide, there is no room for a boss for the set-screw. Therefore, drill a No. 40

hole in the thickness of the eccentric, tap $\frac{1}{8}$ in. or 5-B.A., and fit an Allen screw if you have one that size; failing that, a grub-screw. The gudgeon-pin is a piece of 3/32-in. silver-steel turned down to $\frac{1}{16}$ in. at each end, screwed $\frac{1}{16}$ in. or 10-B.A., and furnished with commercial nuts.

Although the illustrations show the pump stay as a casting, dimensions being given on them, I usually make these small stays by merely



Pump stay and eccentric

bending a piece of brass sheet of requisite thickness, to a shallow-channel shape, just wide enough to fit between the frames. It is easily done in the bench vice, if the metal is annealed. A bent-up stay is very neat. The pump is erected between the driving and trailing coupled axles, the valve-box being set to clear the trailing coupled axle by 3/32 in., as shown in the plan and sectional illustrations. I have already explained how to get the exact length of eccentric-rod, to ensure 1/32 in. clearance between end of ram and end of barrel. The little eye should be case-hardened, for long wearing.

Pipe Connections

Before permanently erecting the boiler, the pipe work, or plumbing, as our cousins over the big pond call it, should be tackled. The diagram shows the connections. First, make up two weeny side clacks to go on the boiler barrel, or a top-feed fitting, just as you prefer. If the side clacks are used, the stems can be screwed into tapped holes in the thickness of the boiler shell, and soldered; this will be quite all right, as they never need to be removed. If the top-feed fitting is used, a bush is needed to screw it into, as it may need removal for cleaning. The bush could be silver-soldered, when the dome and safety-valve bushes are being attended to; or it may be screwed into the thickness of the boiler barrel, and soft-soldered, which is quite in order for such a small boiler.

To get the required lengths of pipe, I usually put the boiler temporarily in place, and run bits of lead wire of requisite diameter, between the starting and finishing points, as I have several coils of lead wire, and no special use for it. Ordinary copper wire can, of course, be used; these wire templates save wasting precious copper pipe. From the forward end of the tee on the pump, a pipe goes to another tee, from each branch of which, a pipe goes around the boiler barrel either to side clacks or top-feed fitting. The pipe from the back end of the tee on the pump, goes to the by-pass cock, or screwdown valve, whichever you like to fit. The pipe from the bottom of the pump is led alongside it, both terminating under the cab sill, which takes the place of the drag-beam on the ordinary type of engine. Take the pipes out below the rear stay or brace at the back of the main frames, and along by the side of the firebox, just clear of the ashpan. You won't need a drawing for that simple job! Make up the lengths of pipe, fit the unions, and attach them before the boiler is fixed "for keeps." The pipe for connecting up the hand pump can be put on after fixing the boiler, as it merely goes from the union under the cab, as direct as possible to the clack on the backhead.

How to Erect Boiler and Cab

The smokebox end of the boiler is fixed exactly as described for *Dot*; but the rear end has a single transverse plate bracket arranged after the style of the Ivatt Atlantics on the old Great Northern Railway. At the front end of the firebox, the inner plate projects $\frac{1}{4}$ in. below the outer plate, both on the slope. Right in the middle of this projection, bend a little over 1 in. of it so that it is vertical, at right-angles to the bottom

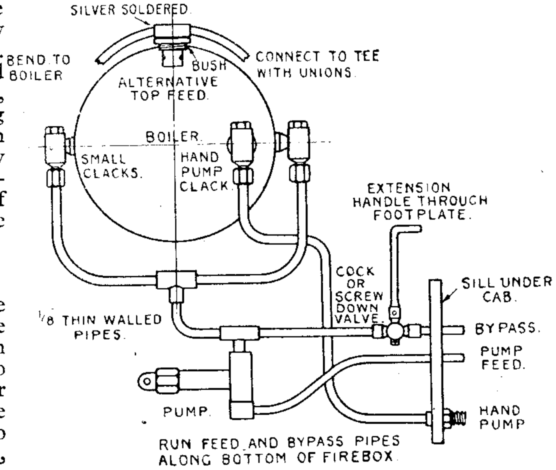
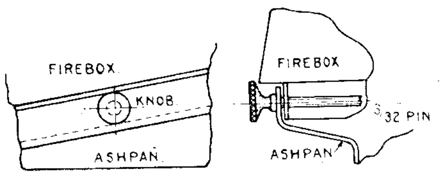


Diagram of pipe connections

of the boiler barrel. This is easily done by catching hold of it with the jaws of a good hefty pair of flat-nosed pliers, and judiciously applying a little "Sunny Jim" in the required direction; as the copper is quite soft after the final brazing process, it is amenable to this treatment. Two or three bites may be needed, according to the width of plier jaws; a hand-vice could also be used, and if the jaws of it are 1 in. wide, same as my own vice (not being a retailer of stale jokes, I didn't leave out the word "vice" after "own"!) the deed can be accomplished at one fell swoop. Cut a strip of 18-gauge brass or copper, 1 in. long and $\frac{1}{2}$ in. wide, and rivet it to the bent part by four $\frac{1}{16}$-in. rivets. Drill three No. 40 holes in the piece of strip below the firebox; and when

the boiler is placed in position, run three 3/32-in. or 7-B.A. screws through the holes, into tapped holes in the stay. Put a short screw in the middle one, so as to leave the hole for the king-pin on the pony truck, quite clear. The whole doings is shown in the illustration. The strip of metal attached thus, is flexible enough to take care of the expansion stresses in such a little boiler, but at the same time ensures a sound and strong attachment.

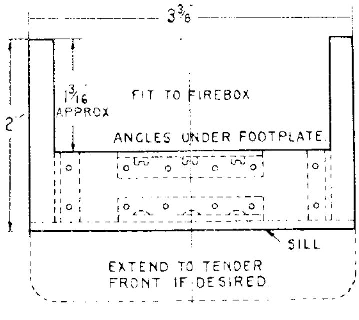
Cut the cab footplate from a piece of 18-gauge sheet metal ; brass or steel will do equally well. It may be either cut short at the back of cab, level with sides, or extended back almost to touch the front plate of the tender, as shown in the various views of the mock-up of the new standard B.R. cab shown in several "full-size" journals ; this extension is shown dotted in our illustration. Leave the gap for the firebox a bit on the small side when first cutting out ; then attach the footplate to the bottom of the cab sides by small pieces of angle, either riveted or soldered, whichever you prefer. The next job is to fit the cab to the boiler ; that calls for a little patience. My own pet antic is to make a template from thin cardboard or stiff paper, and it takes very little time to fit this to the boiler,



Ashpan fixture

after which it is laid on the metal, a scriber run around the "arch," and the sheet metal cut to the scribed line. The result is invariably an excellent fit. The sides of the gap in the footplate may be eased with a file until they fit snugly against the sides of the firebox wrapper.

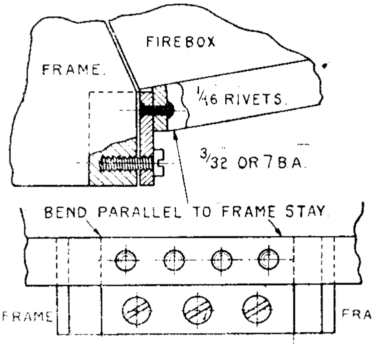
All that is needed to fix the cab to the boiler is a bit of angle about $1\frac{1}{2}$ in. long, riveted to the underside of the footplate, level with the edge of the firebox gap, and screwed to the backhead. As the latter slopes, the angle is sharper than a right-angle, so bend up the needful from a bit of 18-gauge brass about $1\frac{1}{2}$ in. long and $\frac{1}{2}$ in. or so in width, fitting it to the backhead and footplate, so that it lies snugly against each. The sill can be attached to the underside of the footplate by a similar piece of angle, riveted to both ; in this case a right-angle is required. The pipes are attached to the underside of the sill by brackets, same as I usually specify for the pipes under the drag-beam of a larger engine ; but keep them as low as possible, and it would be an advantage to bend down the ends, also bend up the ends of the pipes coming out from under the tender to match, so that the hose couplings won't kink. I see that, according to the mock-up pictures already referred to, my usual arrangement of pipe connections between engine and tender, to enable any tender to be used with any engine, isn't going to be of any use on the new B.R. standard locomotives ; so I'll have to scheme out a new wheeze for pipe connections. No rest for the weary! To prevent the cab having the appearance of being suspended in mid-air when seen from the side, a make-up piece (see general arrangement drawing) can be cut from sheet brass and fixed to the underside of the footplate, at each side of the cab, between backhead and sill. Simply bend over the top, and rivet to the underside of the footplate ; or merely solder it, if you like, as it only needs to be strong



Plan of cab footplate

enough to "stay put," and carries neither weight nor stress. The only alteration needed to the *Dot* tender, is to leave out the spirit tank, fit a sloping bottom to the space it occupied, for carrying coal ; and add feed and by-pass pipes.

Well, I don't think there is any more to say about the weeny-weeny Pacific ; but frankly I am surprised at the way *Dot* and *Diana* have "caught on." I just included them as suitable for an indoor "scenic" railway, perhaps to amuse and interest "railway-conscious" kiddies,



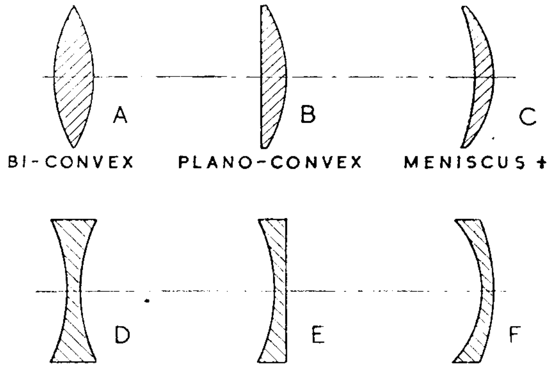
How to fix rear end of boiler

and even give them a ride on an outdoor line ; but I find that builders are making a really serious job of the tiny engines, and have just heard that there has been quite a rush on the blueprints. Maybe the fact that they are cheaply, easily, and quickly built, has a lot to do with it ; my experience is that 99 per cent. of locomotive builders would rather get the wheel turning, and the safety-valves sizzling, than spend years in making useless fallals, so I try to cater for their needs.

* Miniature Slide and Strip Projectors

by " Kinemette "

THE next item to be considered in the construction of the projector is the optical system, and from the many queries on this subject which have been submitted by readers, it is clear that the importance of optical efficiency is fully appreciated, but the principles of optical projection are still commonly regarded as wrapped in mystery. Many readers quote from the results of tentative experiments in the construction of optical apparatus, the results of which are often indifferent, due to defects in the sharpness of definition or unevenness of illumination, or both. The difficulties in this respect usually arise in the attempt to utilise existing, or readily-available optical components, a desirable policy in view of the fact that most constructors have limited financial resources, and have to study economy in these matters. In cases where expense is no object, it is quite easy to specify and obtain just the right lenses to obtain maximum optical efficiency ; but it is often possible to save a good deal of cost with little or no sacrifice of quality, if one only knows something about essential principles. Knowledge is sometimes more useful than unlimited wealth—the buyer with " more money than brains " is often induced to buy something which is merely flashy, with little real quality—and therefore no excuse should be necessary for devoting a little space to an explanation of basic principles of projection, for the benefit of the many readers who have asked for advice on this subject



Forms of simple lenses : A, B, and C, positive or convergent lenses, D, E, and F, negative or divergent lenses

It is first of all necessary to obtain an elementary knowledge of the properties and functions of the various types of lenses. The types shown in the diagram represent the elements which are used either singly or in combination, to make up any lens system ; the exact shape, thickness and curvature of the lenses may not correspond exactly to those shown, but they will come into one or other of these categories. The examples *A*, *B*, and *C* are positive or " convergent " lenses, capable of forming an optical image, while *D*, *E* and *F* are negative or " divergent " lenses, incapable of producing an image by themselves, though they may be used to modify focal length or correct errors when used in conjunction with positive lenses. Any lens which is thicker at the centre than at the edges is a positive lens, and one thicker at the edges than the centre is a negative lens. The optical properties of differend kinds of glass vary widely, and many compound lenses contain positive and negative lenses of different glass, which are used to balance and correct each other.

In a given type of lens, the focal length will depend on the curvature of the glass ; the thicker the centre of the lens in relation to the edges, the shorter the focus, and vice versa.

Optical theory is a very involved science, and to go deeply into it would take up more space than is justified in a purely practical journal, nor is it necessary to do so for the purposes with which we are concerned. Some of the explanations of lens functions which are given are not scientifically complete or even strictly accurate, but they serve the purpose of illustrating basic principles.

In all normal types of optical projectors—the term legitimately includes cameras, enlargers, " magic " lanterns, cinematographs, and projection microscopes—the actual formation of the projected image is effected by means of a lens, known as the " objective," the function of which is to resolve the image on the screen, and produce the clearest and sharpest possible definition. The objective is a common requirement of all optical projectors, though it may vary in design according to the purpose for which it is to be used ; but projection of an image is only possible when the subject is strongly illuminated, and it is often necessary to employ a further lens or lenses to obtain the maximum illumination from the available source of light.

The basic principles of the diascopic projector are illustrated in the diagram herewith, which shows how the light rays emitted from the light-source *L* are transmitted through the slide *S*, and from there through the objective *O*, which converges the rays at the focal point *F*, beyond

**Continued from page* 604, " *M.E.*," *April* 27, 1950.

which they again diverge until they reach the screen *P*, where they can be sharply focused to form an inverted image by suitable adjustment of the relative positions of *S* and *O*. This shows the simplest possible optical system, and in practice it does not produce the desired results, mainly because the rays from the light-source do not illuminate the slide evenly all over; assuming that the rays emanate from a small area in the centre of *L*, they will tend to pass in as direct a line as possible through *O*, leaving the margins of *S* almost or completely dark, as shown in the next diagram.

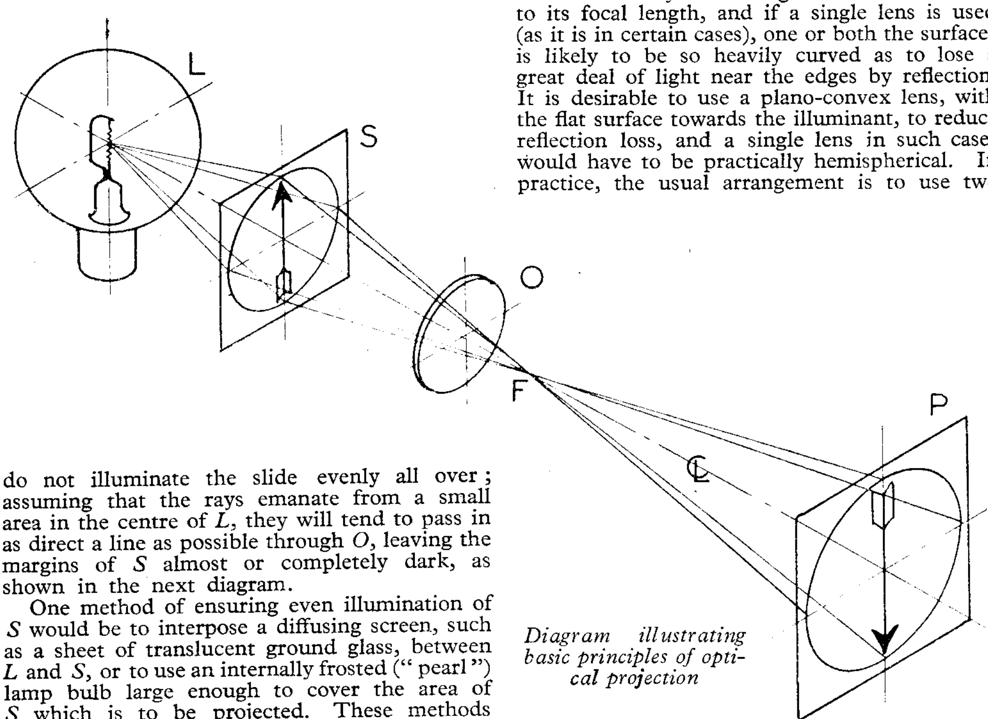


Diagram illustrating basic principles of optical projection

One method of ensuring even illumination of *S* would be to interpose a diffusing screen, such as a sheet of translucent ground glass, between *L* and *S*, or to use an internally frosted ("pearl") lamp bulb large enough to cover the area of *S* which is to be projected. These methods have often been used in enlarging lanterns, where evenness of illumination is more important than efficiency of light transmission. (A modern version of the idea is to use a fluorescent type of lamp having a large screen area). But diffusion of light is a wasteful process, and may result in a loss of 75 per cent. or more of the transmitted rays. A much more efficient method of ensuring that all the surface of *S* is properly illuminated is to use a condenser *C* between it and the light-source *L*.

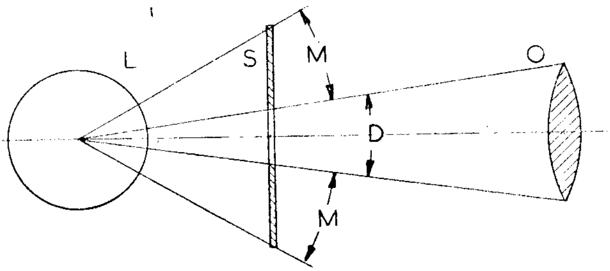
The Condenser

Essentially, the condenser is nothing more than a simple lens of sufficiently large diameter to cover the entire subject area of *S*, and of a suitable focal length to re-converge all the rays which it receives, at such an angle that they pass through the objective *O*. The condenser normally plays no part in the formation of the image, and therefore does not have to be of high optical quality. It is, however, possible to combine the function of condenser and objective more or less efficiently in a single lens system, and this is sometimes done in cheap toy lanterns; but in practically all the standard forms of diascopic lanterns the condenser and objective lens systems are separate and distinct.

In the diagrams on the next page, both the objective and condenser are shown as simple biconvex lenses, but in practice it is found desirable to use compound lenses for one or both systems. One reason for this is to avoid using lenses of excessively deep curvature, which are expensive to grind and difficult to correct. The condenser must necessarily have a large diameter in relation to its focal length, and if a single lens is used (as it is in certain cases), one or both the surfaces is likely to be so heavily curved as to lose a great deal of light near the edges by reflection. It is desirable to use a plano-convex lens, with the flat surface towards the illuminant, to reduce reflection loss, and a single lens in such cases would have to be practically hemispherical. In practice, the usual arrangement is to use two plano-convex lenses with their flat sides outwards, and convex sides fairly close together; this represents a good compromise between ideal optical efficiency and production economy. Some high-class projectors employ a triple lens combination, the rear lens (nearest the light source) being a meniscus, that is, concave on one side and convex on the other, but thicker in the centre than at the edges. With the concave side towards the illuminant, this lens is capable of collecting the rays over a very wide angle, with little reflection loss.

The cheaper forms of condenser lenses are often simply moulded, with little or no subsequent grinding or even polishing. These give reasonably good results, though light losses are greater than with optically ground lenses, and there may possibly be some unevenness of illumination due to strains or faulty moulding of the glass. Scratches or other marks may show up badly if they are on the surface nearest to the slide, but are less sharply defined if on the other surfaces and may be so far out of focus as to become invisible. It is well to know this, as one may possibly obtain lenses with slight faults very cheaply, and they can often be arranged so that the faults do not show at all.

The size of condenser used must always be a little larger than the area of picture to be covered, allowing for the fact that the rays of light converge on leaving the condenser, and therefore the farther away from the slide, the larger the condenser must be. There is some advantage in using a large condenser at some distance back from the slide, in cases where space can be spared. A condenser which is only just large enough to cover the slide may produce objectionable coloured fringes at the corners, which cannot be eliminated by focusing ; it is better to mask off the frame and sacrifice a little of the picture area than to allow these to show on the screen.

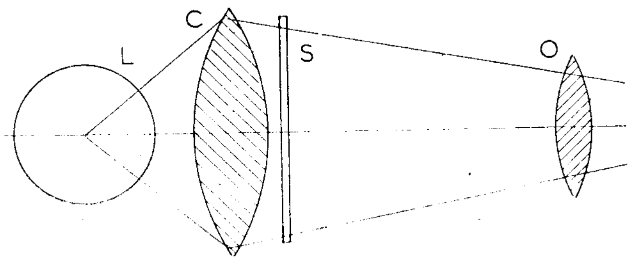


When no condenser is used, only the direct rays D illuminate the slide effectively, the margins M being left partially or completely dark

A condenser may be dispensed with in cases where only a small area is to be illuminated, by using a large and efficient parabolic mirror focused on the aperture. This is highly efficient, and is used in the "mirror arc" system of illumination in full-sized cinemas ; but it requires more space than can conveniently be allowed in a small projector, and is rarely used for the purpose under consideration.

Conjugate Focus

The focal length of a lens is taken as the distance from the lens centre at which it forms an image, when the subject is an infinite distance away, so that light rays from it impinge on the lens in a practically parallel path. To illustrate this, one may take the case of a simple lens being used as a "burning glass" to focus the sun's light and heat rays on a very small area ; the distance at which the lens must be held from the spot on which the heat is concentrated represents the focal length. (This is not strictly true, because light and heat rays do not focus at exactly the same point, but it will serve for explanatory purposes.) If, however, the light rays reaching the lens are not parallel, but emanate from some point nearer than infinity, the focal point will occur at a greater distance from the lens. In the case of a condenser, it is desirable to bring the lens as close as possible to the source of light in order that it shall collect as large a cone of rays as possible ; as a result the apparent focal length of the lens is considerably increased, as shown in the diagram. The relation between the focal points at the front and back of the lens respectively is known as conjugate focus, and in practice it means that the closer the light is to the rear side of the condenser, the farther away from the front of the latter is the point at which the rays are brought to a focal point ; and this is where the objective should be situated to enable the maximum efficiency and evenness of illumination to be obtained.



By introducing a suitable condenser lens C, the entire area of S can be evenly illuminated, and the light rays "steered" through O

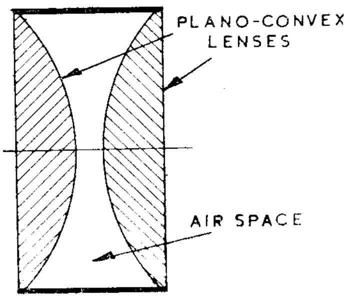
With the normal arrangement of an optical projector, the distance between the condenser and the objective may often be as much as twice the nominal or "infinity" focal length of the former ; it will be apparent that a fair amount of latitude in the focus of the condenser, to suit objectives of different focal length, is possible if the light source is capable of lateral adjustment. It is, of course, also necessary to be able to adjust the position of the light crosswise, both vertically and horizontally, to ensure that the light rays are accurately "aimed" through the centre of the objective.

The Objective System

As this lens must be capable of forming an image, its optical qualities are much more important than those of the condenser. In a simple lens, the ability to form a sharply defined image is mainly dependent on accuracy in grinding and polishing, and a good lens of this type is capable of acting as an objective more or less

satisfactorily, subject to certain limitations. Many of the cheaper types of "still" or cine projectors have been fitted with objectives consisting of simple lenses, either single or double, and the standard of definition obtainable in this way has evidently satisfied the users of such projectors. The simple lenses from watchmaker's oculars, which are obtainable in a range of focal lengths, have often been recommended for use in home-constructed projectors. For the longer focal lengths, spectacle lenses, which are usually of excellent optical quality, can be used, and small hand magnifying glasses also give reasonably good results.

While it is possible to calculate focal lengths by careful measurement of the surface curvature, in cases where no data on the subject is available. it is generally much easier and quicker to find it by actual test. A rough test may be made by focusing the rays of the sun, or a distant artificial light, on to a ground glass screen or sheet of paper—even the back of the hand, when nothing else is available—and measuring between this and the lens centre. In the case of this particular projector, a lens of about 3 in. focal length is suitable, and either a single lens of this focus, or two lenses of about 6 in. focal length mounted a short distance apart, may be used. The single lens will produce the most brilliant results, being least liable to losses by reflection and diffusion, but the doublet may often be found to give better definition, owing to the smaller curvature near the edges; and a symmetrical doublet, composed of two identical lenses, can be so arranged as to correct the distortion, which is always produced to a greater or less extent in a single lens.



Usual form of condenser lens for optical projectors

Faults in Lenses

Where a high standard of projection quality is called for, simple objective lenses, either singly or in combination, are hardly good enough, however well they are made. Many of the prospective constructors of projectors have expressed the demand for a very high quality of definition—which is quite a reasonable demand, in view of the extremely high enlargement of the film strip or miniature slide, and the fact that, being stationary, it is subject to much more critical scrutiny than a moving picture—but it undoubtedly complicates the problem of finding a really suitable objective lens. In listing the faults which are likely to be found in simple lenses—and often in lenses alleged to be "corrected"—the object is to show what correction methods may be applied, and to assist the constructor in selection or adaptation of available material.

Chromatic Aberration.

Simple lenses suffer from the disadvantage that they cannot focus rays of different colours all to the same point, but tend to produce a spectrum, in the same way as a Newton prism. This results in producing a coloured fringe—like that seen in a badly registered colour print—which interferes with sharp definition of the image, and in practice is often very conspicuous and objectionable. If only black and white pictures were projected, with a truly monochromatic light, this fault would not occur, but in practice some colour is always present, either in the picture or the light-source.

To correct this fault, two mated lenses, one positive and the other negative, and made of two different kinds of glass having distinct refractive and dispersive properties, are used in combination, usually cemented together. Such lenses are known as "achromatic" combinations and are used in all high-class telescopes, binoculars, gunsights, etc.; they look like simple lenses, but their superiority is nearly always apparent if they are used merely as magnifiers. Some kinds of magnifying lenses have achromatic correction, and are known as "aplanatic" magnifiers, though the term is rather confusing as it is used in a different sense when applied to projection and camera lenses.

Spherical Aberration

This fault, sometimes also termed "curvature of field," is due to the fact that a flat surface is obviously closer to the lens at the centre than at its margins, and in consequence, the natural tendency of a simple lens is to focus the marginal rays at a shorter distance than those at the centre. In practice this means that when the centre of the picture is sharply focused, the corners will be blurred, and vice versa Flatness of field can be produced by special design and correction of the lens, and where simple lenses are employed, those of the plano-convex or meniscus type, if suitably arranged, are generally better than double-convex lenses in this respect.

It will be fairly clear that the effects of curvature of field will be more pronounced in lenses which are required to cover a large angle in relation to their focal length, than in those which cover a narrow angle. For this reason, lenses of long focal length in relation to the size of the "frame" or slide area which they have to cover, are generally advisable for projectors. Whereas photographic lenses often have to work over a wide angle, the diagonal measurement across the plate or film being equal to the focal length, the respective proportions are more often in the region of 1 to 3 for projectors. Flatness of field can also be improved by introducing a restricted diaphragm or "stop," to reduce the aperture of the lens in relation to focal length,

(*Continued on page* 676)

Novices' Corner

Hand Knurling

THE knurling of components in order to provide a gripping surface for the fingers is a lathe operation which the novice will find frequent occasion to carry out. Whilst for heavy work it is essential to employ knurling tools especially designed for the lathe slide-rest, hand tools give satisfactory results when used for knurling small components such as instrument screws and the like; indeed, in the past, scientific instrument makers almost always employed hand methods for knurling.

Fig. 1 depicts a hand knurling tool and it will be seen that it consists of a wooden-handled shank fitted with a hardened pin upon which the knurling wheel revolves. The pin is made a light drive fit in the shank so that it may readily be removed when changing the knurls.

The knurl wheels have a pattern formed on their periphery, and this is transferred to the work by bringing the knurl into contact with the surface whilst it is revolving in the lathe. At one time, it was possible to obtain knurling wheels with a wide variety of patterns, but, nowadays, the range seems to have shrunk to the four patterns shown diagrammatically in Fig. 2, a, b, c, d. Of these a, b and c are the most useful, but it will be realised that the pattern which is transferred to the work is the *reverse* of that on the knurl-wheel itself. Therefore, pattern d will appear on the work as a series of diamond shaped indentations bordered by lines crossing one another.

The hollow, straight knurl shown in Fig. 2c is particularly useful for finishing instrument screws that have a curved periphery.

Impressing the pattern upon the work requires pressure; for this reason the surface to be knurled by hand should always be kept as narrow as possible, for the wider the surface the greater will be the force needed.

To produce a clean pattern quickly in soft metals, such as brass or aluminium, it will be sufficient to lay the knurlholder on the hand-rest, as shown in Fig. 3A, and to push the tool into the work by applying pressure in a horizontal plane at right angles to the lathe axis. In the case of steel, however, much more pressure is needed and the method shown in Fig. 3B must be used. Here, it will be seen that the hand-rest is employed as a fulcrum, allowing considerable leverage to be exerted on the knurl wheel thus forcing it into the work. Attention, however, must be called to the detrimental effect of this practice upon the headstock bearings of a light lathe. Unless special precautions are taken, prolonged use of the knurling tool in this manner will cause undue wear of the bearings and will impair the accuracy of the lathe. Therefore, whenever possible, the tailstock must be brought up and the work supported on a centre. This will relieve the headstock from the levering stresses that would otherwise be imposed. Of course, it is not absolutely necessary to give this additional support from the headstock when knurling narrow surfaces by the method shown in Fig. 3A, for the pressure exerted is so much less, but,

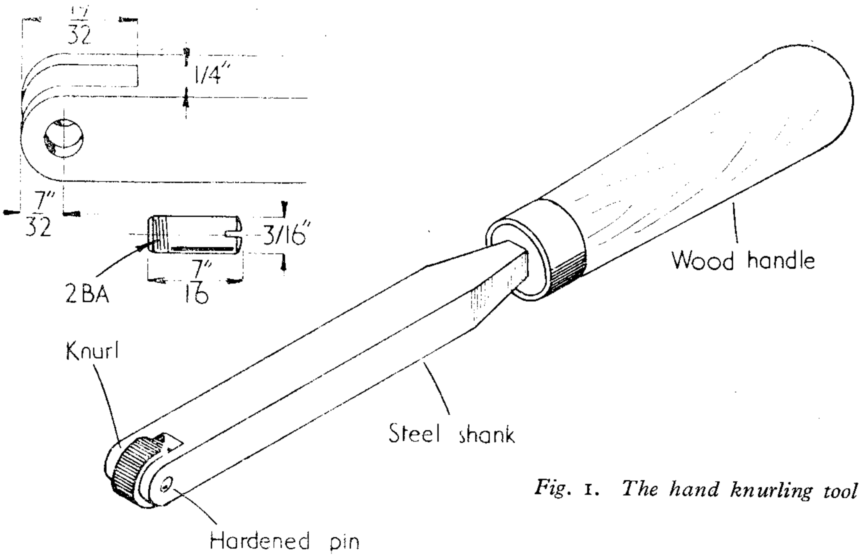


Fig. 1. The hand knurling tool

even so, consideration for the well-being of the lathe will suggest that the work should be supported whenever possible.

The knurling process is only effective when the work is running dead true. Therefore, the work must be turned true before the knurling operation is begun ; alternatively, the part must be set accurately in the four-jaw independent chuck by means of a dial test indicator. Knurling must be carried out with the work free from oil, otherwise the small metal particles which become

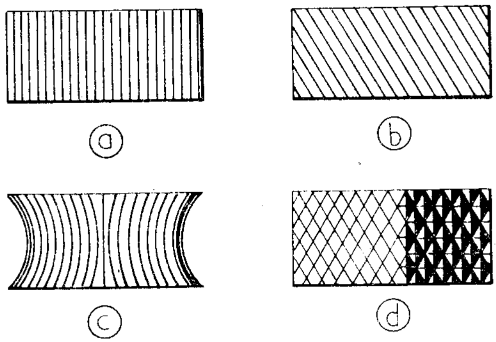


Fig. 2. *Types of knurling wheels*

detached from the component will float in the lubricant and be rolled into the pattern imparting to the knurling a lack of sharpness. Examination with a magnifying glass, after wire-brushing the work, will reveal any lack of finish in the knurling. It is always advisable to examine knurling with a strong glass before deciding whether the finish is satisfactory. Many a piece of knurling, which appears to the naked eye to be well finished, will not bear closer inspection with a hand lens. The appearance of good workmanship is marred by indifferent knurling, and examples of this are sometimes seen at exhibitions.

Those who would like to study the subject of knurling in greater detail are recommended to read *In the Workshop*, Vol. 1, published by Percival Marshall & Co. Ltd., where the whole matter is dealt with, and both hand and machine methods are described.

The wheel holder illustrated in Fig. 1 is the pattern usually obtainable from tool merchants, but some of the better class of knurlholders have a screwed axle for the wheels in place of the drive-in pin illustrated. This is an obvious advantage, for repeated removal and replacement of this part will eventually cause the pivot to become slack in the shank.

The making of a knurlholder is a piece of work which the novice may well undertake for himself. The components are simple, a file handle, a piece of rectangular section bright mild-steel bar for the shank and a short length of mild-steel from which to make the axle for the knurl wheel. Before starting work, however, the wheels should be obtained to ensure that the parts of the holder are made to suit. Hand knurling wheels are usually bored $\frac{3}{16}$ in. and are $\frac{5}{8}$ in. diameter by $\frac{1}{4}$ in. wide. It will be quite satisfactory, therefore, to make the shank from a piece of $\frac{7}{16}$ in. square mild-steel as this dimension will leave 3/32 in. of metal on either side of the wheel.

As a guide to those who wish to make the holder, a detail drawing of the wheel mounting is included in Fig. 1.

A 6-in. length of $\frac{7}{16}$-in., square section, mild-steel should be marked off so that a slot, $\frac{1}{4}$ in. wide by $\frac{3}{8}$ in. deep, can be formed in one end. First, however, the holes in the jaws to receive the wheel axle must be marked off and drilled. As one of the jaws is eventually to be tapped 2 B.A., a No. 24 drill is first put through the material leaving the actual tapping, and the opening out of the opposite jaw to $\frac{3}{16}$ in. diameter, till after the slot for the wheel has been formed. The slot may now be cut by first drilling a 7/32 in. hole at the base of the slot so that a hacksaw, making two longitudinal cuts, may break into the drilled hole. This will remove the bulk of the surplus metal, leaving what little remains to be filed out until it is found that the knurl wheel fits in easily.

The jaw which requires a clearance hole is now drilled No. 13, after which the opposite hole is tapped 2 B.A.

The screwed axle or pin requires to be threaded so that the threads are square with the long axis

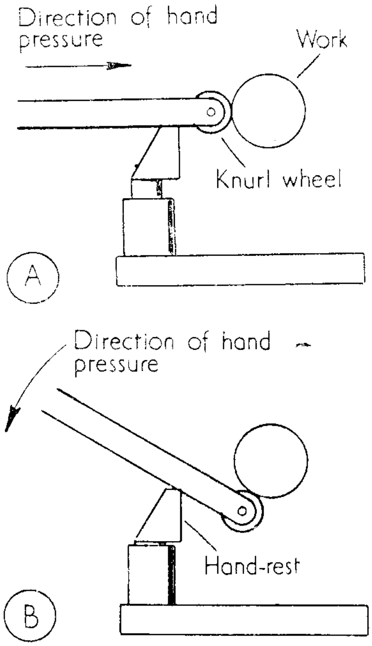


Fig. 3

of the pivot pin. This thread should therefore be cut, centre in the lathe, using a tailstock mounted die-holder, or by hand with a die-holder fitted with a collet, as described in "Novices' Corner," Jan 19th of this year.

Both the pin and the jaws of the shank must be case-hardened to prevent wear.

The tail end of the shank is now filed to a taper so that it can be driven into the file handle.

It is essential for producing good work that the knurling wheel should revolve truly on its pivot pin ; that is to say, the bore of the wheel should be concentric with the patterned surface at the circumference ; for, if this is not the case, it will be difficult to keep the knurl pressed evenly against the work when the knurling operation is carried out by hand. Moreover, when two opposed wheels are mounted in a special holder and the lathe slide-rest is used to guide and move the tool along the work, any lack of concentricity in the wheels themselves will cause the knurling pressure to fluctuate, so that at one instant it may tend to crush the work and at the next it may be insufficient to give a proper impress.

It is prudent, therefore, to buy only best quality knurling wheels made by a manufacturer of repute ; in addition, it is advisable to test any knurls of doubtful accuracy before putting them into use. Reference is made to this matter, as wheels having eccentric bores are sometimes purchased unwittingly ; but it will be found that knurls of the best quality do not fail in this respect, for the bores are ground true and the side faces are finished by a grinding process which ensures that all wheels are of an exact thickness.

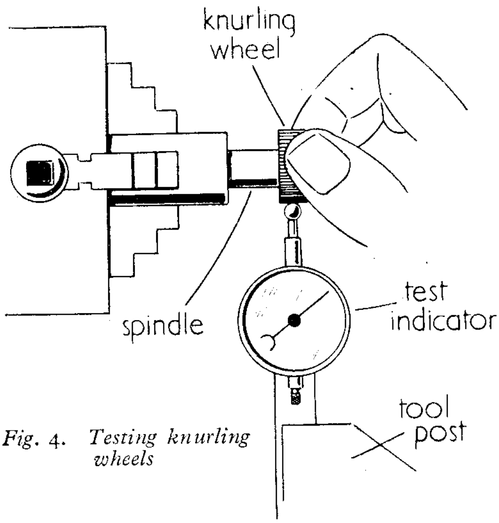


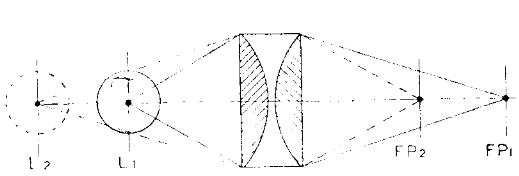
Fig. 4. Testing knurling wheels

A ready method of testing knurling wheels is illustrated in Fig. 4. Here, the wheels are mounted one at a time on a well-fitting spindle held in the lathe chuck, and the test indicator is then secured in place in the lathe toolpost. With the lathe mandrel remaining stationary, the contact point of the test indicator is brought to bear on the wheel which is then slowly rotated on its pivot with the fingers.

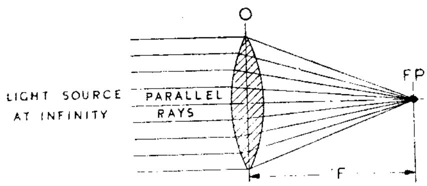
In this way, a direct reading is obtained that will at once show the exact degree of any eccentricity present.

Miniature Slide and Strip Projectors

(Continued from page 673)



Conjugate focus of condenser ; rays emitted from L1 are brought to a focal point FP1, and those from L2 at FP2



The distance F between lens and focal point of rays received from a light source at infinite distance is the nominal rated focal length

but this lowers the efficiency of light transmission and is not desirable in a projector lens.

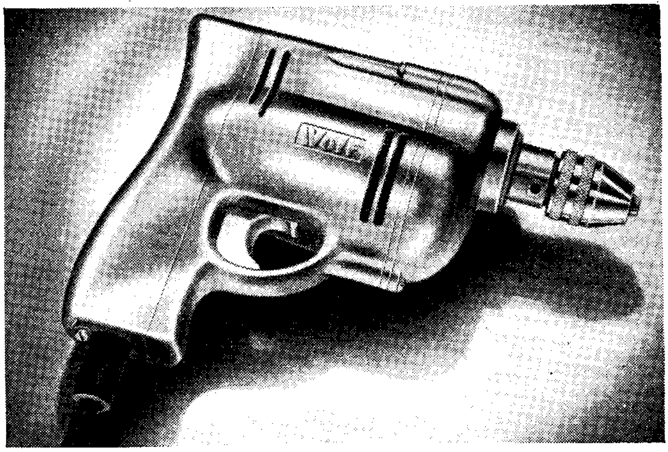
Curvilinear Distortion

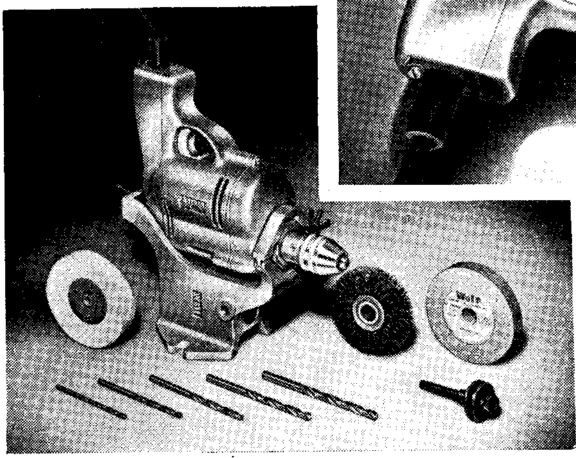
Simple lenses, or unsymmetrical compound lenses, are liable to produce distorted images, especially near the outer margins, so that lines which should be straight are represented as curves. Unlike curvature of field, this fault is accentuated, rather than corrected, by restricting the diameter of the aperture, and the position of the stop relative to the lens influences its nature and extent. With the stop in front of the optical centre, the image of a square object on the slide would appear barrel-shaped, and with the stop behind the optical centre, it would be shaped like a pincushion. The remedy lies in the arrangement and detail design of the lens components.

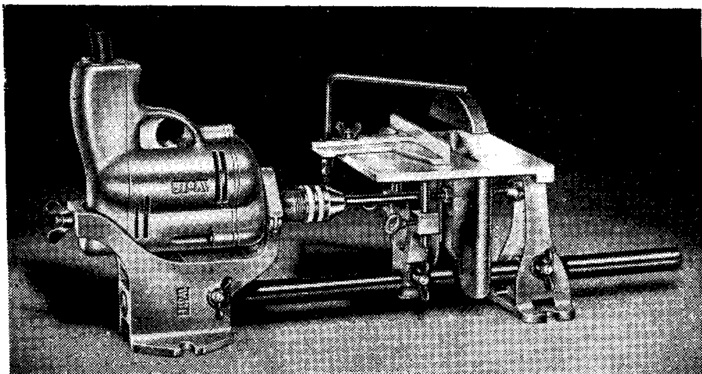
Having defined the besetting sins to which lenses are liable—or at least those likely to be most troublesome to the constructor of a projector—some practical advice on the adaptation of available material, to the best possible advantage, will be given in the next instalment.

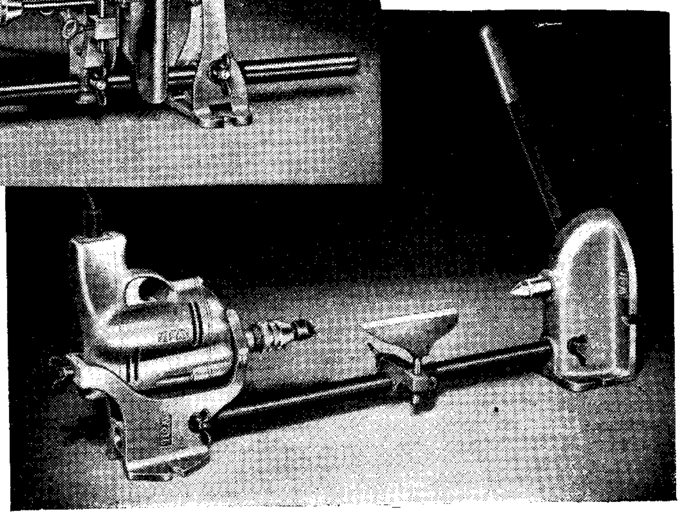
(To be continued)

The Wolf Cub Home Constructor Kit









ON Friday, April 21st, at the Caxton Hall, Westminster, Messrs. Wolf Electric Tools Limited, Pioneer Works, Hangar Lane, London, W.4, demonstrated to a Press gathering their latest equipment, designed especially for the home constructor and handy-man.

Consisting of three basic units, centred around the Wolf Cub Electric Drill, each assembly represents a unique and compact piece of machinery capable of turning out a large variety of component parts for numerous household appliances, as well as candlesticks, egg cups, etc.

The illustrations show clearly the attractive appearance of the equipment and it needs little thought to realise the many useful purposes which such a kit would serve in the average home or model workshop.

The vertical drill assembly is arrived at by upending the lathe (below), removing the tool rest and substituting the faceplate for the tailstock centre.

Further details, including prices of individual assemblies or complete kits may be obtained from the manufacturers.

*The Elements of Maintenance

for 10-c.c. Racing Engines

by G. W. Arthur-Brand

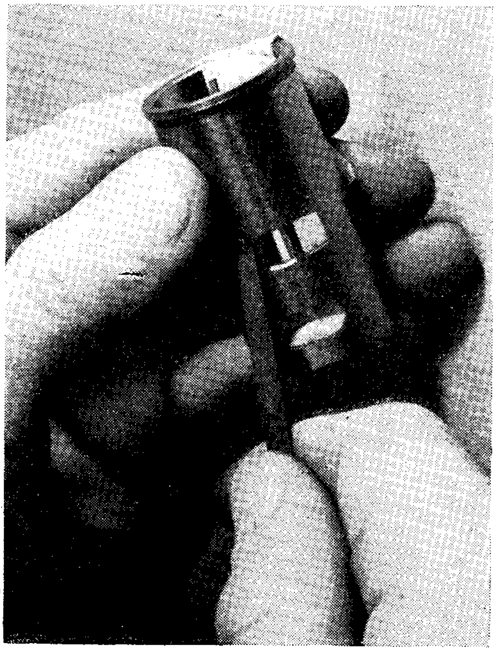
AS each component part is inspected, it should be carefully wiped over with a clean rag moistened with petrol, dried and replaced in its envelope. Any replacements or modifications should be entered on the face of the envelope, which can then be sealed pending reassembly of the motor.

Our next step will be to check the liner for scoring and concentricity. Careful observation will usually be sufficient to indicate to the experienced hand whether or not the wear has been more or less uniform ; but should there be any doubt, a pair of internal calipers, delicately handled, or, better still, a dial test indicator will be found useful.

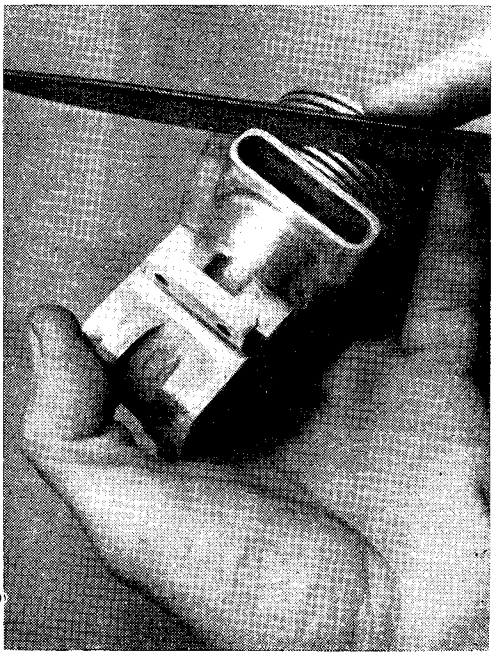
Should it be proved necessary to discard the existent liner, it will be advisable to replace the piston rings, so these can be ordered at the same time. Check the piston, applying the external micrometer at close intervals around the o.d. Should it be the slightest bit out, order a new piston, too !

Having decided either on maintaining the old liner or replacing it with a new one, the following procedure will be the same in both cases : It will usually be found that the porting is left rough-broached or drilled by the manufacturers. This is quite normal, as it would involve considerable additional expense with consequent increase in selling price to carry out squaring and " streamline " operations. It is obvious, however, that in order to obtain maximum performance from any engine, everything possible should be done to ensure free and unobstructed flow of the gases, so, with a fine file of suitable dimensions, let us start by, first of all, squaring the ports, so that they are all exactly the same dimensionally. Next, break all the outer edges and round the corners off, being careful not to damage the bore or upper lip in any way. A piece of folded paper inserted and held as shown in the accom-

**Continued from page* 622, *" M.E.," May* 4, 1950.



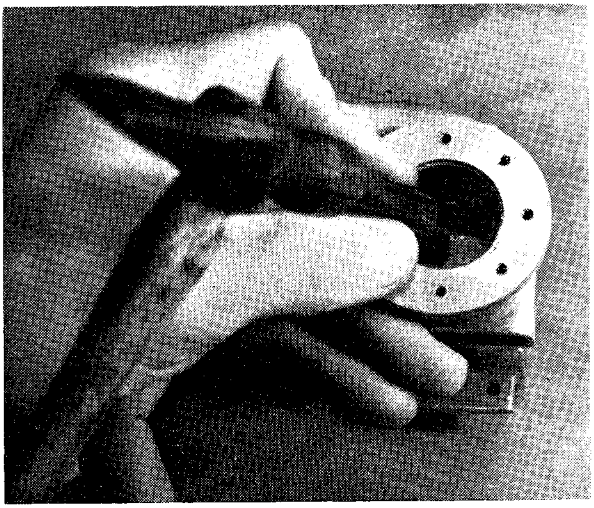
The cylinder liner must be very carefully handled, and in carrying out filing operations on the ports, a piece of folded paper should be inserted and held as shown to protect the bore from possible damage



Lightening of the main casting may be carried out by removing surplus material with a file. In this example, the rectangular exhaust-port is being rounded off. Note that the job is being held in the hand—a vice would be likely to result in distortion

panying illustration will be found a useful safeguard against this. Final polishing with a narrower file wrapped with fine emery will give a satisfactory finish.

The cylinder and crankcase unit can now receive attention. If a sand casting, the possibilities are that a considerable amount of weight can be saved by careful "paring" and wall thicknesses may be checked in order to confirm this. You should be warned, however, that the removal of excessive "meat" may quite easily ruin the motor; so remember, exercise a little discretion!



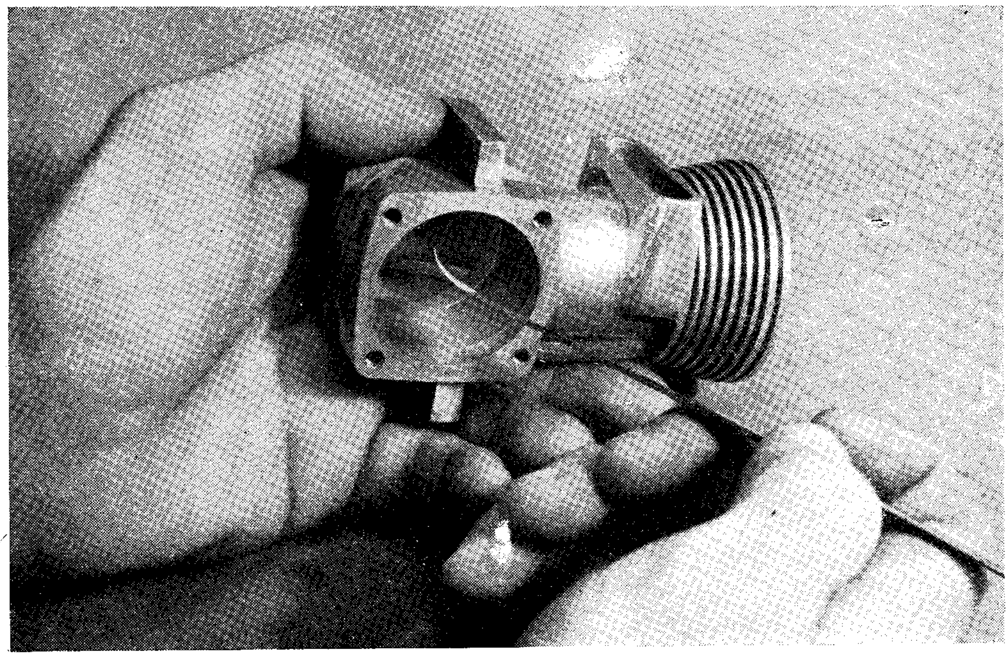
Removing the platform. Care must be exercised when chiselling to ensure that the top seating for the liner is in no way damaged. Held as shown, the finger and thumb of the left hand will cushion any deflection of the tool

Our chief concern should be to ensure that the transfer passage is completely free from obstruction and as highly polished as the available elbow-room will permit. Some engines have a platform at the bottom of the cylinder which considerably hinders the smoothness of flow and tends to strangle the entrance to the passage. This can be removed as shown, again being very careful not to damage any of the machined faces.

Reference to the relevant photographic illustration will show how the job should be held. On no account should it be placed in a vice, as either damage or distortion will inevitably occur.

When the platform has been removed by chiselling, a small scraper, ground up and bent from the tang of an old file of suitable size, will be found quite satisfactory for use as a secondary tool.

(*To be continued*)



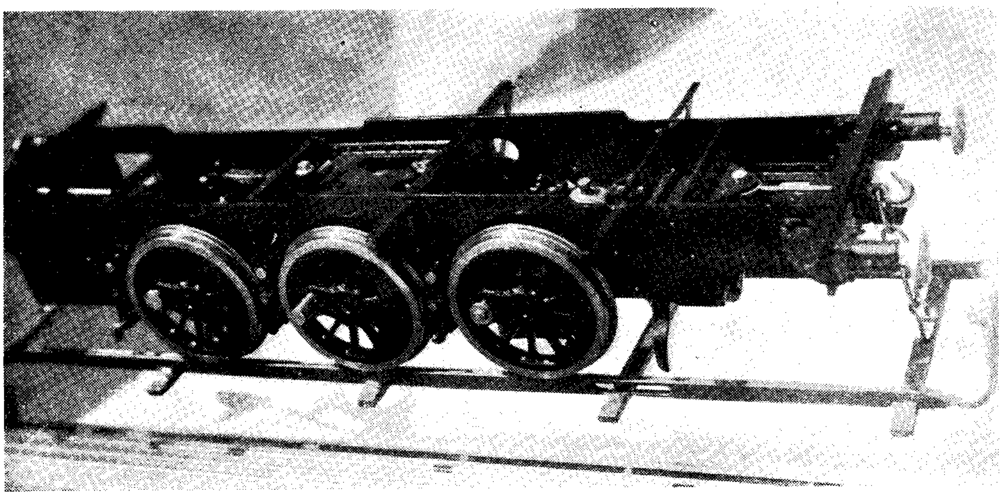
This picture shows the clean entry to the modified transfer passage on the old type Rowell "60," and the small curved scraper used to obtain the necessary internal finish

*TWIN SISTERS

by J. I. Austen-Walton

Two 5-in. gauge locomotives, exactly alike externally, but very different internally

I HAVE just received a very kind letter from Mr. J. Elliott, of Arnold, Nottingham. He is building as a very first attempt at locomotive work, a " Major " Twin Sister. He entered this at the Nottingham S.M.E.E. exhibition, in the club locomotive section, and gained a bronze medal—the second prize. He also tells me that his success is due to the description and drawings given in these notes which is all very flattering and that sort of thing, but not quite the truth. The success is entirely due to him for his care and patience in tackling a job which cannot be described as " a simple engine." I have been most careful in telling you that the " Major " in the series, calls for a lot of exacting work and good workmanship—that is why " Minor " was included for those who felt that their own particular skill or equipment was not quite up to the standard required.



A " Major " first attempt—and a bronze medal winner

Two photographs of this prize-winning engine are reproduced herewith. The prints are a little lacking in definition, although, with the aid of a glass I can make out most of the detail, and it looks good to me. Unfortunately, prints which are not very clear, lose a lot of definition in the block-making and printing. So here's congratulations to Mr. Elliott for a fine piece of work, and all good luck until its completion.

By the same post, came another letter from a Mr. Jack Horsfall, of Waddington, Lincoln, asking me to reassure readers in these notes regarding the casting supply position. Once before, I mentioned that our friends, Kennion Bros., of Hertford, were in a position to supply all castings described in these notes, and I have not heard of any cases of refusal. A delay in getting an order executed might be due to a run on existing stocks which would soon be corrected when fresh supplies came in.

When last I spoke to Mr. Dick Simmonds, he told me he would also be prepared to supply castings and materials to anyone who cared to make application to him, so I cannot feel that there is any need for builders to be in difficulties in this direction.

Sand Boxes

Believe it or not, if you want to be in a position to make up your frames for good, you must build and drill for the sand boxes, or at least, the two front sand boxes that go inside the frames. Whilst doing these, one might as well make up the set, and have done with it. It is so easy to get into a rut with locomotive building, and to reach that state of mind where you believe that assembly *must* follow a certain, fixed order. The fact that we *know* that the engine will run correctly when finished, enables us to fit such things as brake-gear, at a time most convenient

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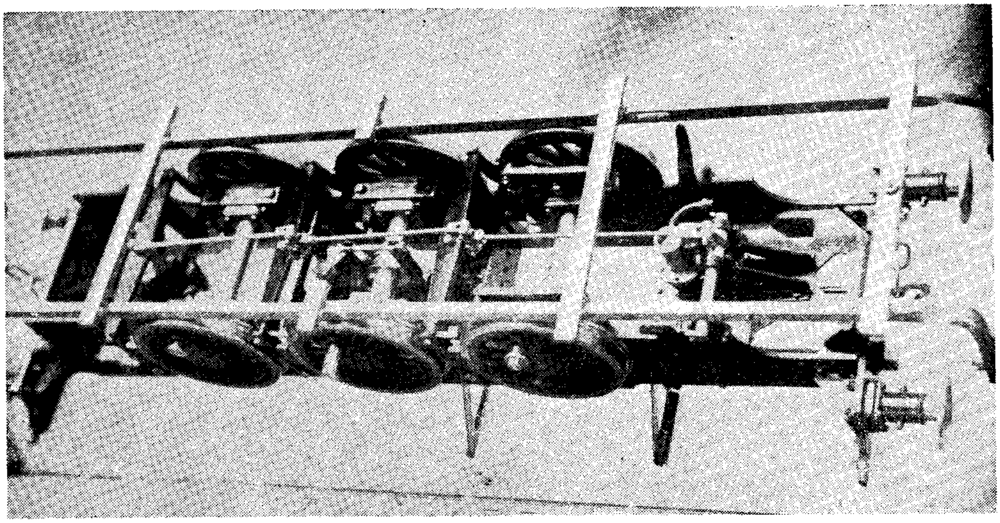
**Continued from page* 559, " *M.E.,*" *April* 20, 1950.

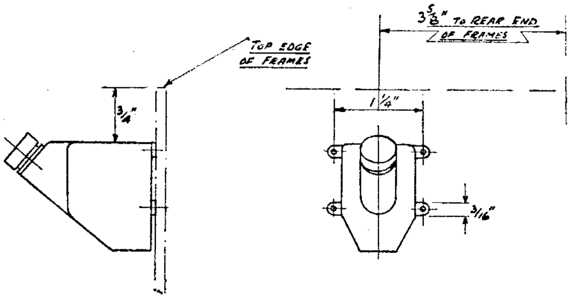


A neat job—from every point of view

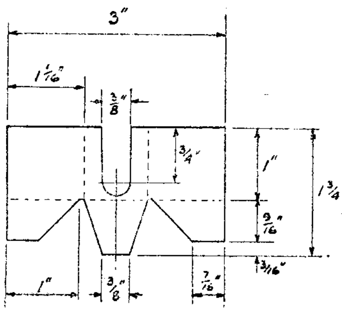
to do so. I would hate to ride in a motor car that had brakes added, just as an afterthought or a luxury addition ; starting *and* stopping are both equal partners in the matter of the safe control of any wheeled vehicle, and I refuse to be lured away from this rather sensible belief.

The drawing shows the sand box blanks and finished outlines. Two complete sets have been made, dimensions proved, and no serious snags found. When first I handed the drawing to friend Duncan for his next bit of " homework," he gave me one of his extra-dirty looks, and started to bleat, " Why can't you give me something that I can *machine* instead of this wretched bending business ? I *hate* bending dirty little bits of brass." I shooed him out of the back door, and let him get on with it. Two days later I went round to see him, and thought he looked a bit smug ; after an indecent silence and interval, he turned the offending items out of his pocket with a nonchalance that suggested that five minutes had sufficed for their manufacture. The ice was broken. " Any difficulties ? " I asked. " Had to trim the ends and edges of the blank a bit before they would meet up, but it didn't amount to much ; and then I silver-soldered them, and filed them up." Now, I had used my oxy-acetylene set to do the joining up, using Sifbronze wire with the result that a nice round fillet rested on the corners for filing away to the required rounded edges.

On further questioning, Duncan told me he had used a special war-surplus silver-solder, the name of which he didn't know ; it did not run in the same way as " Easyflo," but tended to remain in a more plastic state, once it had fused and run into the joint. This enabled him to do quite a bit of building up, which is a distinct advantage in this particular case. He also told me that once the joint was made, a much greater heat was required to re-melt it, and, as there were other parts to be silver-soldered to the boxes at a later stage, he could not have laid hands on a more suitable material. I have used and know the characteristics of Messrs. Johnson Matthey's " B.6," which is a good sister material to " Easy-



REAR SAND BOXES (FITTED OUTSIDE FRAMES)
2 OFF — IN 16G. BRASS.



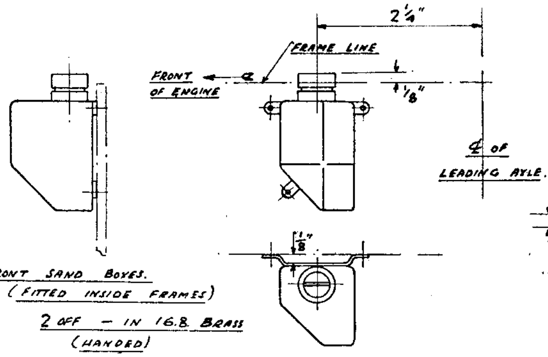
BODY BLANK

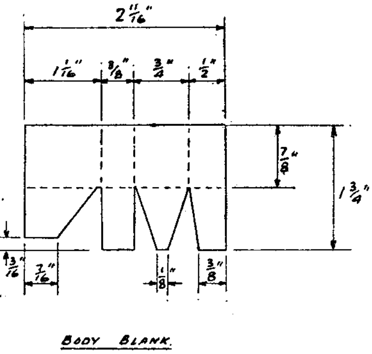
flo," having a slightly higher melting point. I have been able to make up fabricated assemblies comprising a number of small parts, and to silver-solder in places not more than $\frac{1}{4}$ in. away from a "B.6" joint, without any fear of the earlier joints coming unstuck.

Cutting Out and Bending

First of all, let us regard the shape of the blank edge of the spout. This is probably where you will discover some surplus length in the tongue; but without there being anything fixed together, it is an easy job to file back metal to suit the case.

When the parts are properly shaped, you should be able to assemble them roughly, and to insert the shank of a $\frac{3}{8}$-in. drill into the opening left for the spout, without pushing the spout neck away from the front of the box.





as being approximately right, for without special bending jigs, two men will take the same blank and produce entirely different shapes. As the sand boxes are not exactly precision items, slight variations in finished dimensions will not matter at all.

When the blanks of all the parts have been cut out, they should be annealed over an ordinary gas-ring, bringing the brass up to an almost invisible dull red, and then quenching it in water. Start the actual bending on the sides of the body of the box, afterwards turning your attention to the lower bits that all slope in, to meet in a kind of bluff square cone. With the back of the box still open, it is easy to trim slivers off the sides of the "vee" tongues until they will all bend to meet each other. Fiddle about like this until the small ends of the tongues leave a space between them of about $\frac{3}{8}$ in. square. Now tackle the back of the box, bending up the lower flap that will form the extreme bottom of the box, first of all. This will give you a clue as to where the first main bend will come—the back to top edge bend, where it forms the lid of the box. The whole of this back plate should fit in between the sides of the box, including the top plate portion.

Now, deal with the spout or filler portion. The blank shown for this is very approximate indeed, but being such an easy part to trim afterwards, the surplus metal provided is of no consequence. The easiest way to make the spout is to cut out a little metal block, the exact shape of the *inside* of the spout; that is, $\frac{1}{16}$ in. smaller than the outside shape. Bending the brass round the block is just child's play, after which you can file or cut away any surplus, using the block as a kind of filing-jig.

By offering up the finished spout member, you can now determine the manner of bending the extended part of the top flap of the box, which you will see slopes down to suit the top

It is quite a good plan to turn up the little cap sockets, and silver-solder these in place when you carry out the main silver-soldering operation. You will find that the tongue which is part of the top and back, will serve to hold the spout member from moving during this latter performance. There is nothing else likely to move.

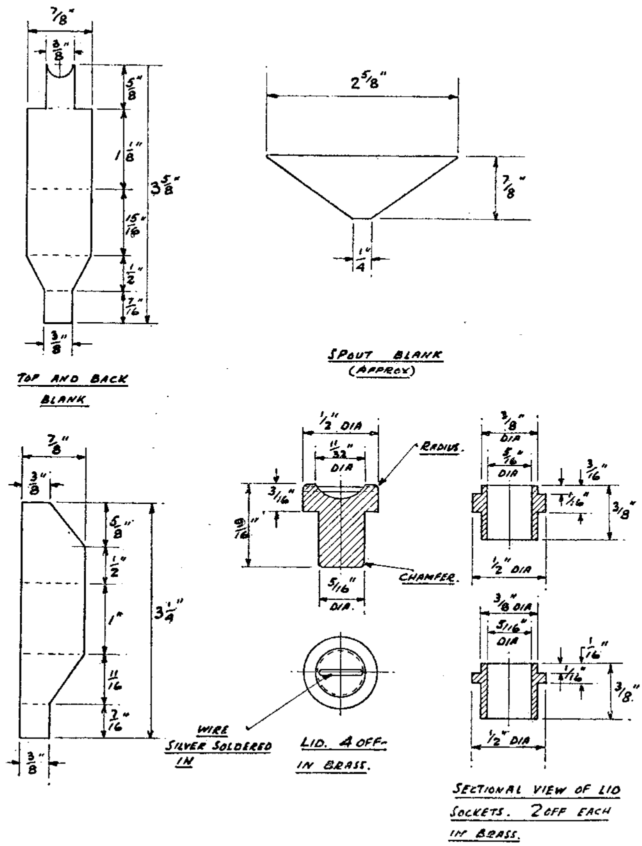
Weld or Braze?

As I have said already, welded and silver-soldered joints have both been tried, and both are suitable. If ordinary silver-solder is used, of a variety that will not lend itself to a built-up fillet (and not so very many of the grades *will* do this) then forget all about leaving a fillet of brazing, carrying on as with a normal type of joint. When the job has been quenched and cleaned up, you can tin the edges, and build up your fillets with ordinary soft-solder. The boxes have only to be sand-tight, not a very exacting condition, and will never be subjected to heat, and the required strength will be in the initial silver-soldering, in any case. Before doing this, however, it would be as well to deal with the other structural details of the boxes.

The inside boxes have three-point fixings, due to certain space considerations, but these will be ample in any case. The drawing shows straps across the backs, made in 20-gauge brass, and cranked to throw the box away from the bolting face. When you offer up the box to the inside of the engine frames, you will see that it straddles a brake hanger nut on the inside. There is no need for this to project more than $\frac{1}{8}$ in., so, if it does, remove both pin and nut, shortening the pin and turning the nut down to reduce its thickness. You will see that a general position is given for the box, which is not very critical either. The very shape of the box suggests its correct place, being sloped on one side to clear and match up with the draw-hook eye-brackets

made on to the No. 2 stretcher. If everything has been made to drawings, the top forward foot of the sand box will come just above the turned back flange of this stretcher, the single lower fixing will be well in the clear, and the other top fixing should be a safe distance above the end of the leaf-spring blade and adjustment nut.

The fixing straps of the rear sand boxes are quite flat and have nothing to miss. The positioning is clear and straightforward to the dimensions



given. On the prototype, these boxes are placed rather more forward, but as we are fitting working traps and ejectors which absolutely refuse to be scaled down below a certain point, we are confronted with the space bogey once more. The guard-irons happen to come just on the centre-line of the sand boxes, and as these stick out to the equivalent of 5 ft. instead of 4 ft. 8½ in., things are made more difficult still. After the most careful thought, I have seen fit to modify the sand box position without anything being made to look out of place, and it makes the run of the sand-pipe much neater, to say nothing of a less acute bend in the pipe itself.

If the straps for both front and back boxes are fixed by means of tiny countersunk brass screws, you will be able to silver-solder these on to the boxes also in the same operation, and with no fear of their getting moved or knocked off while the box itself is being turned this way and that, in the blowlamp flame. As for the holes for attachment to the engine frames, 10-B.A. would be the approximate scale size; so you must argue it out with your conscience. But just let me catch the vandal using 4-B.A. cheese-head brass screw!

The inside sand boxes will need a $\frac{3}{8}$-in. hole drilled in the top, to take the lid socket (mind your fingers, there) and mind you use the right socket; the one with the wide collar belongs to the front box, as you will see if you study the drawing. All four boxes will need an outlet hole in the bottom—*not* shown on the drawing. This should be $\frac{1}{4}$ in. dia., and drilled in the centre of the square base of the box.

The lids for the boxes are all alike; turn these up to the outline given, leaving out the spherical sunken cavity in the head. Drill a transverse hole to take a piece of wire, about $\frac{1}{16}$ in. dia. will do, afterwards replacing the lid in the lathe when the cavity may be turned out. You will find it much easier to drill the head when it is solid, than to risk breaking the drill when it breaks out into the sloping side of the cavity. The wire, when inserted may be silver-soldered, soft-soldered, or just lightly riveted over at both ends, and cleaned off. On the prototype, this wire will form the handle of the lid or plug.

Please Sir, Can I?

I know what you are going to say—can you fit dummies, especially as you will never use real sand in the boxes?

For "Minor," I was going to suggest dummies in any case, and these might take the form of cast aluminium blocks to the same outline as the real boxes—it would never show up with paint to hide the secret, and they would be dead easy patterns to make, even for the veriest beginner. The dummy sand-traps and ejectors could then be made dead to scale, and screwed directly into tapped holes in the bases of the solid boxes. I think every possible choice must surely be found in some combination of the foregoing alternatives.

There is just one tiny voice, right at the back row—can you make the boxes in solid cast iron, to make up artificial adhesive weight? Well, you *can*, not that I think you will need it, and you are going to be the one who will have to hump the engine round with you; so it's up to you!

Now, here's a sensible suggestion: when the engine is turned upside down for cleaning, the lids of the sand boxes will fall out and get lost—remedy—underneath each lid fix a tiny brass wire eye; to this you can fix another brass wire, made with an "S" crook in its middle, and a

very small tension spring at its lower end which, in turn, can be fixed to the bottom of the inside of the sand box. The lid will then be held down by the spring, and on pulling out the lid, the "S" bend in the wire will provide a sort of catch which will hook over the rim of the lid socket, just in case you want to fill the box with sand and keep the lid out of the way whilst so doing. Get the idea? This is purely a refinement, but a sensible one; there are other ways of making the lid "captive," and you may prefer to work out your own system on different lines.

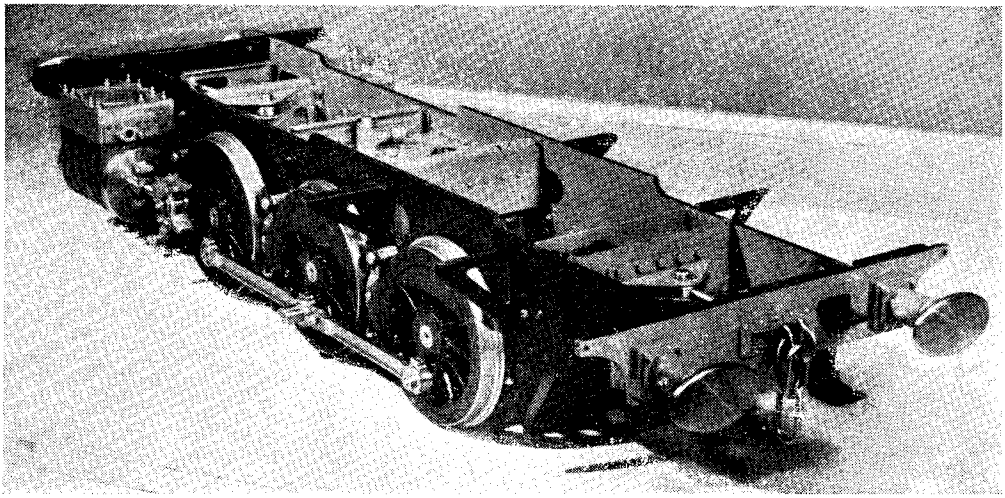


Photo by] *"Major" No. 1—plenty of detail here* *[H. Duncan*

Change of Subject

This, in fact, happened recently when I started to lay out a very accurate geometry of the motion for this engine; I hope to produce this in drawing form and for reproduction here. It has turned out to be a most revealing and satisfying document, and with everything going to plan. The valve events are perfect, and there should be no valve-setting tears anywhere.

As a matter of interest, I compared the events obtained with those of the prototype, and the characteristics are identical, which, in a way, is hardly surprising. It does seem to me to be strange that a gear like Walschaerts should have so many "interpretations" where there should be only one. The facts are simple enough, and when you study the mathematics and geometry of this type of valve-gear, it is easy to realise that there is but one setting—the correct setting. Acute angularity, die-block slip, and a number of other weaknesses inherent more in the setting out of the job than in the design itself, account for the indifferent results it is *possible* to obtain; but it is better to study these things when considering the layout of the gear, than to try to alter the true characteristics of the *system.* Incidentally, I do believe in the bits of tin, cardboard, and drawing-pin method of playing with valve-gears; I think it teaches one a very great deal, and I always did like the direct approach to any such problem.

I also hope to be able to announce the issue of blueprints of all the "Twin Sister" parts through THE MODEL ENGINEER offices. A number of the more recent drawings have been made, and are ready for issue. Meanwhile, the work of preparing some of the earlier drawings is in progress.

(To be continued)

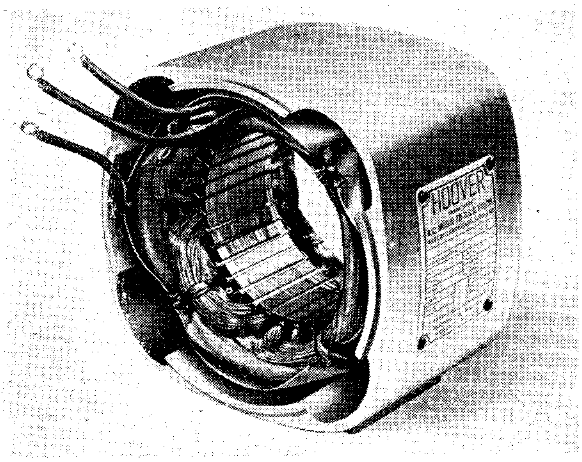
Sharpening Scribers and Centre-punches

The grinding of scribers and centre-punches has always caused me some bother, and examination of the business end of these small tools with the aid of the watchmaker's eyeglass usually shows a rounded cone rather than a sharp point.

Grinding-rests, with the usual V-notch have been used with varying results, the main trouble being that to examine the fine point closely, one needs a watchmaker's glass, and this entails bringing one's face too near the high-speed emery wheel for comfort. I find that a very satisfactory way of doing this small job, is to chuck the scriber or punch, as centrally as possible in the lathe, then, using the highest speed, hold an ordinary flat oilstone against the point at the correct angle, gently rubbing it up and down until the required angle and sharpness of the point is obtained. The edge of the stone is suggested, as this operation is likely to score the surface. The two hands using the lathe bed as a rest, can guide the stone very accurately. The magnifying-glass can be used with safety and the sharpening operation closely observed throughout.

Should a broken scriber be amongst those for resharpening, it is best to grind the point roughly on the emery wheel first.—E. F. AMOS.

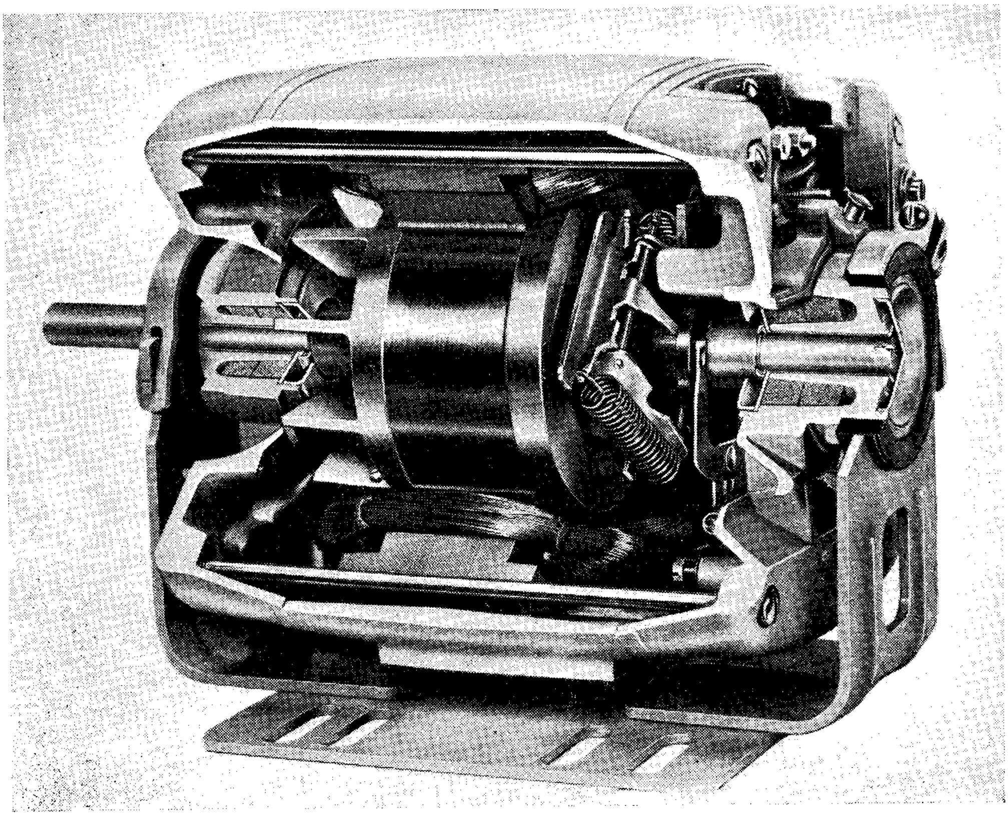
New Hoover F.H.P. Motors



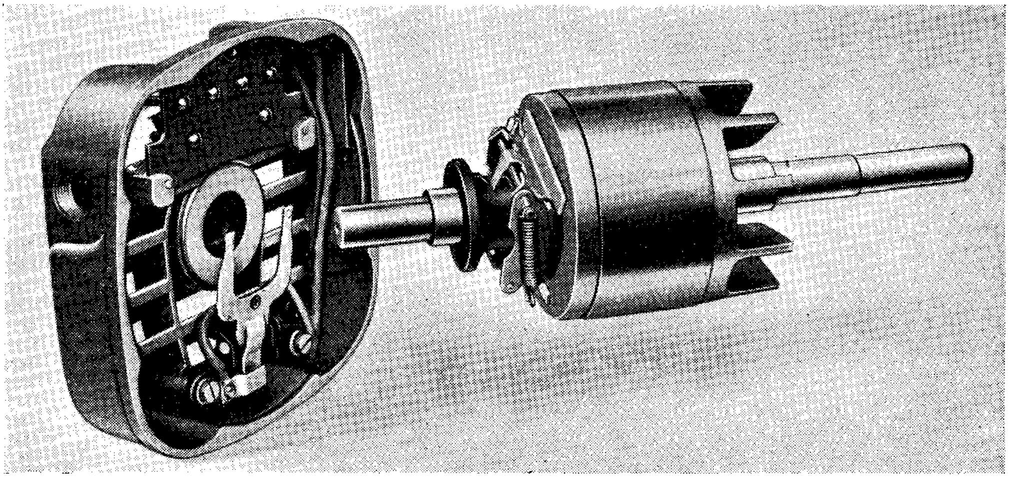
Wound and insulated stator unit ready for assembly

MESSRS HOOVER LTD. have recently introduced an entirely new range of factional horse-power a.c. induction motors, embodying many interesting features of design, in addition to improved methods of construction. The sizes range from 1/6 h.p. to $\frac{3}{4}$ h.p. and include single-phase (split-phase or capacity start) and three-phase (star or delta connected) types, in all standard main voltages, including provision for dual voltage in certain cases. In addition to the 4-pole type running at 1,425 r.p.m., which is the most popular for general industrial application, 2-pole (2,850 r.p.m.) and 6-pole (950 r.p.m.) types are also produced.

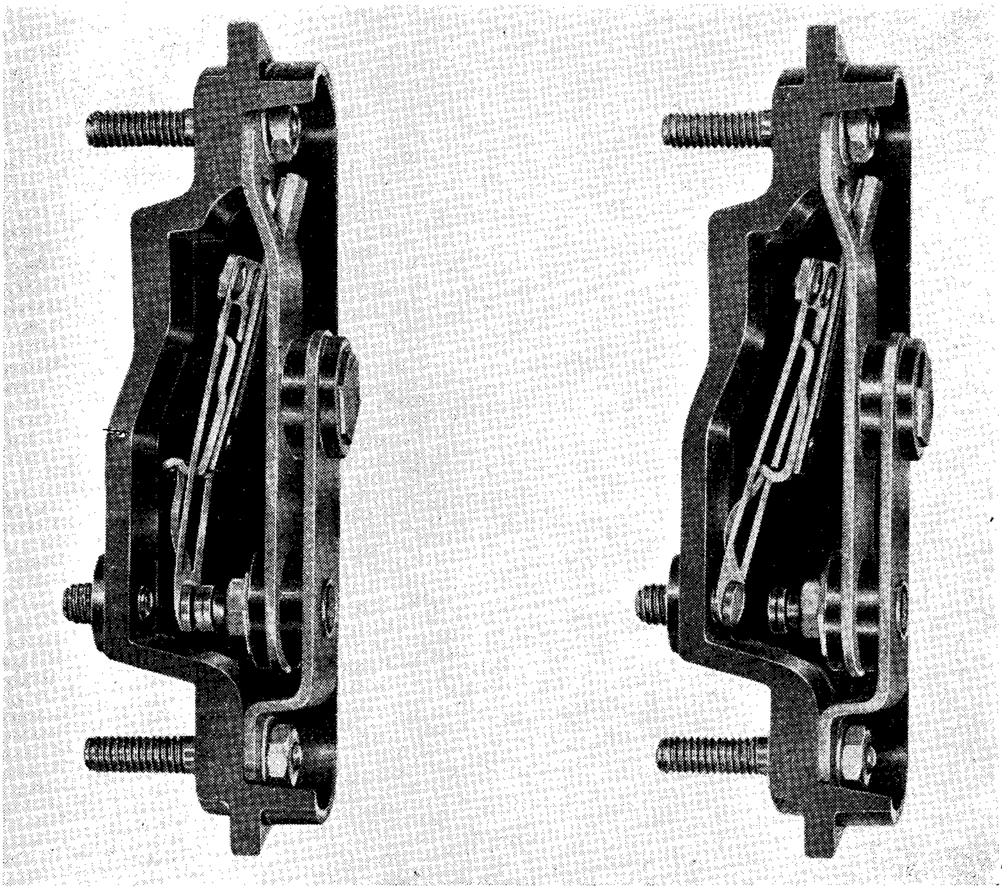
In the construction of all these motors, die castings have been extensively employed, facilitating high precision of structural parts without increasing production costs. The rotor, which is of the normal " squirrel-cage " type, is greatly simplified by having the laminations cast into a



Sectioned $\frac{1}{4}$ h.p. split-phase, drip-proof motor, sleeve-bearing, resilient mounting



Terminal end-frame and rotor, showing mechanism of the centrifugal starting switch



Automatic reset thermal overload cut-out, shown in circuit and " tripped "

mass of solid metal which forms the end-plates, conductor bars and cooling fan in one integral unit, and the entire assembly is keyed to a shaft $\frac{7}{8}$ in. diameter. Similar methods are employed to incorporate the stator laminations in the main body casting.

In the case of single-phase motors, a centrifugal switch is fitted to the rotor and operates through a pair of toggle levers and a sliding sleeve to cut the starting windings out of circuit when running speed is reached. This enables the motors to be switched directly on to the line without the need for special starting switches. Either ball-races or sleeve-bearings may be fitted as standard in all types, the former being equipped with grease nipples and the latter with oil fillers feeding felt wicks which hold sufficient oil for long running periods.

Four alternative forms of mounting are provided, namely, solid foot, concentric flange, and resilient, with or without automatic belt tensioner. Efficient cooling systems are provided both in the drip-proof and totally enclosed types, and the temperature rise on continuous full-load duty is unusually low.

A terminal box is sunk into the upper part of the end frame so that all connections can be made without the need for projections outside the frame, thereby preserving a clean exterior contour. The inside of the box cover contains a wiring diagram for the appropriate type of motor and the terminals are clearly marked. An entirely new feature, which can be supplied as an optional fitting, is a thermal overload switch, operated by a bi-metal strip acting on the micro-switch principle, and arranged to be re-set either by hand or automatically ; this also is fitted in the terminal box.

The new constructional design and the improved methods of production adopted, enable these motors to be sold at a competitive price. They are manufactured entirely at the Hoover motor factory at Cambuslang, Lanarkshire, Scotland, and are obtainable from all dealers in electric power equipment.

PRACTICAL LETTERS

Hot Air Engines

DEAR SIR,—The letter from "Corvus" which appeared in the "Practical Letters" of the March 16th issue contains a rather misleading statement which I feel calls for comment.

I fully endorse his statements concerning design, workmanship and selection of materials. This does not mean I agree with his design, workmanship or selection. I have not had the opportunity of examining his engines and cannot therefore judge. Nevertheless, the assertion he makes in his last paragraph leads to me think I should not be very favourably impressed.

Many so-called single-acting engines do, in fact, impart almost as much power from the impulse given on the return stroke as from the power stroke, but this is invariably due to faulty design (too long a stroke of the power piston relative to the volume of working medium contained within the system) or poor workmanship which allows leakage to atmosphere of some of the working medium (air). When this occurs, the pressures within the engine fluctuate above and below that of the atmosphere, and although such engines run more smoothly, particularly at low r.p.m. and can therefore be fitted with smaller and lighter flywheels, they do not possess the power of similar engines, correctly made and working in pressure ranges always above that of atmosphere.

Yours faithfully,
Hailsham. R. T. A. BROWN,

Feed Pump Calculations

DEAR SIR,—I have been asked by my father, Dr. Fletcher, to reply to the two letters which you have published, in which certain criticisms were made of the method by which he calculated the required output of his boiler feed-pump.

The first criticism is, of course, perfectly justified, it being the reference to the error in stating that N.T.P. is 0 deg. F. and 760 mm. pressure. Of course, as both gentlemen pointed out in their letters, the scale of temperature should have been the Centigrade one which, of course, is used for all scientific purposes. I am afraid the only excuse that can be offered for this error is that, as a doctor, my father is rather short of leisure-time and wrote his letter rather quickly.

The other criticisms are as follows :—

(a) That the gas-laws do not apply with sufficient accuracy to steam in the conditions in which it is found in small engines.
(b) No reference was made to cut-off.
(c) That gases do not behave as might be expected from the equation $P \times U = K$ at extremely low temperatures.

In reply to (a) I would like to point out that the original calculations for the pump in question were made with the aid of Dr. Charles Buchanan who is a lecturer at Glasgow University and a brilliant physicist. While in no way denying the fact that the gas-laws are not strictly observed by comparatively wet steam, he was of the opinion that the percentage allowed for losses from all sources was quite ample. This is borne out in practice by the behaviour of the plant of which the pump is part. Of course, as pointed out by Mr. Westbury, such a method of assessing water consumption can only be used in cases where the load on the engine is practically constant. In the case of boats this is a fairly safe assumption to make.

Referring now to (b) :—

No mention was made of cut-off in order to simplify the hypothetical calculation and this in no way affects the basic calculation. The only thing one has to do to allow for cut-off is to make the output of the pump the same percentage of the basic calculation as the percentage cut-off used in the engine.

The third criticism (c), as pointed out by Mr. Winter who made it, has no bearing whatsoever on the question, as, of course, steam cannot, by any stretch of imagination, be referred to as having an extremely low temperature!

So much for the criticisms. I would like to make it quite clear that far from objecting to them, we welcomed any criticisms which have been made and hope that, in spite of the fact that the application of the method of calculation suggested is limited, it has helped, at least, a few of our brother model makers.

In conclusion I tender my father's apologies for not replying personally.

Yours faithfully,

Colne. G. FLETCHER.

Making Piston Rings

DEAR SIR,—With reference to query No. 9782, from W.B. (Morpeth), on the above subject, I would first of all advise him to get makers' oversize rings, and fit these by filing the gap until it gives the usual 0.003 in. per inch of diameter measured at the bottom of the bore. Rings can usually be obtained in oversizes of from 0.005 in. to 0.060 in.

I have made successful rings for a diesel engine out of cast-iron pipe, the method being to rough machine the "pot" from which the rings are to be cut leaving a generous allowance over and above the theoretical reduction in diameter of $\frac{\text{Gap}}{3.14}$ due to the cutting and closing of the gap. The pot is then slotted along its length, the slot being the same width as the desired gap, and gripped in the three-jaw chuck until the gap is closed. It is then finished to size and the rings parted off. If a hefty enough chuck is not available, a clamping ring with set-screws to grip the work can be made to close the gap.

I wonder whether any readers remember the D.8 tractor at the School of Military Engineering, Roorkee, which had a complete set of these home-made rings. It wasn't content with making blue smoke, but showered its surroundings with a fine mist of black oil! It is only fair to say that the rings were working in very worn bores, and they did at least convert a wreck into a runner.

Yours faithfully,

Sheffield. G. PENNIALL.

Electric Clock Contacts

DEAR SIR,—In your reply to query 9777 by D.B.G. (Sheffield), regarding spark quenches on electric clock contacts, you advise him to connect a condenser of not less than 1 Mfd. across the contacts.

This will, I agree, absorb most of the self-induced current when the contacts break, but it will cause even greater arcing when the contacts close, due to the rapid discharging of the condenser. It is the usual practice, when using a condenser for spark quenching purposes, to insert a small choke in series with the condenser to limit the short circuit current. A small bell coil is quite satisfactory for this purpose and it should be fitted either with its original iron core still in place or with a steel bolt through the centre to provide a core of magnetic material.

The use of a condenser across the contacts will also cause a small continuous current to flow through the clock sustaining coil, when the power supply is a.c. This current might affect the operation of the clock, since it will cause a dragging effect on the driving mechanism. It may be possible to overcome this dragging effect by slightly increasing the supply voltage to the clock, but I would strongly advise D.B.G. to consider the possibility of driving his clock from a d.c. supply.

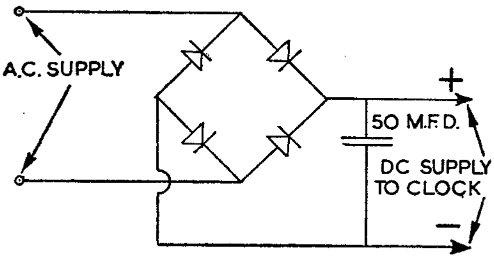


Diagram No. 1

This could quite simply be achieved by inserting a small bridge rectifier in the a.c. supply to the clock, with a condenser to smooth out some of the resulting ripple. The type of rectifier and condenser would depend on the voltage and current required by the clock. The circuit would be as diagram No. 1.

It does not seem to be generally known that a rectifier can be used to form an extremely efficient spark quench on a d.c. circuit when connected as in diagram No. 2.

The polarity of the rectifier is important, since its function is to present a high resistance to the

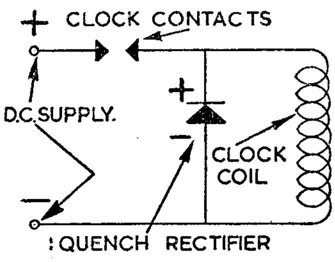


Diagram No. 2

supply voltage and a low resistance to the self-included voltage in the coil. For supply voltages up to about 50 V a small rectifier such as the Westinghouse 1/6 A is very satisfactory for this purpose.

Still further reduction in arcing would be obtained by using both the condenser-choke quench and the rectifier quench.

If D.B.G. would care to let me have further particulars regarding the working voltage and circuit of his clock, I will gladly send him an assortment of contact screws.

Yours faithfully,

Leeds. H. G. BICKERDYKE.

Queries and Replies

Enquiries from readers, either on technical matters connected with model engineering, or referring to supplies or trade services, are dealt with in this department. Each letter must be accompanied by stamped, addressed envelope, and addressed: "Queries Dept." THE MODEL ENGINEER, 23, Great Queen Street, London, W.C.2.

Queries of a practical character, within the scope of this journal, and capable of being dealt with in a brief reply, will be answered free of charge.

More involved technical queries, requiring special investigation or research, will be dealt with according to their general interest to readers, possibly by a short explanatory article in an early issue. In some cases the letters may be published, inviting the assistance of other readers.

Where the technical information required involves the services of an outside specialist or consultant, a fee may be charged depending upon the time and trouble involved. The amount estimated will be quoted before dealing with the query.

Only one general subject can be dealt with in a single query; but subdivision of details into not more than five separate questions is permissible. In no case can purely hypothetical queries, such as examination questions, be considered within the scope of this service.

No. 9807.—Pressures in a Car Engine
G.R. (Dagenham)

Q.—I would be very much obliged if you could furnish the following information: the pressure, in pounds per sq. in., produced in the combustion chamber of a low h.p., four-cylinder car engine at the time of the ignition of the mixture.

R.—The pressure in the combustion chamber of an internal combustion engine usually amounts to from three to four times the compression pressure, varying to some extent with the type of fuel used.

In the case of a motor-car engine having an *actual* compression pressure of 75 lb. per sq. in., this would amount to 225 to 300 lb. pressure.

With regard to the time actually occupied in complete ignition, it is not so easy to answer this, as the question is at present the subject of a good deal of advanced research work, but here again the type of fuel is a very important factor, and fuels are designed to give accelerated or retarded rates of combustion, according to the purpose and the type of engine for which they are intended to be used.

No. 9805.—Conversion of Optical System
R.C.M. (Plymouth)

Q.—I have a full-size magic lantern fitted with very good lenses and I am desirous of converting it to a projector for showing 16 mm. films. If you think this can be done, perhaps you will advise me where I can obtain a detailed plan of the necessary mechanism and its arrangement.

R.—The optical and illuminating system of a magic lantern can be adapted for use in a cinematograph projector, but if the original objective lens is retained, the size of picture which can be projected with a normal length of throw, will be very small indeed, especially when projecting 16 mm. films. The focal length of an objective used in a magic lantern is rarely less than 6 in. and more usually 9 in. or more, whereas for a 16 mm. film, it is rarely that a lens of more than 2 in. focal length is employed. We think it would be much better to use only the illuminating system of the lantern, that is to say, the lamp-house, lamp and condenser and fit complete cinematograph projector mechanism, including a short focus objective lens. The design of the "M.E." home cine-projector would be quite suitable for this purpose.

No. 9804.—Radiometer and Harmonograph
R.W.E.L. (Liskeard)

Q.—I wonder if you could help me on the two following queries:—

(1) You may remember the "light windmills" which we often saw as advertisements before the war in shop windows. These were four small vanes mounted within a glass bulb—silvered one side and blacked the other, which continued to revolve when exposed to daylight. Can you tell me if and where these can now be obtained?

(2) There used to be on the market a toy table machine made up of two freely swinging pendulums mounted on gimbals—one pendulum with a small platform and the other mounted with a pen. When set swinging the pen marked out the resultant path of the two pendulums describing what is known as Lissajous' curves. Is it possible to obtain one of these toys?

R.—(1) The device you refer to was known as a radiometer, originally invented by Sir William Crookes, and often exhibited in the windows of opticians and scientific instrument makers as a mechanical novelty. We have not seen any of these for many years, and we presume that they are no longer made, but it might be advisable to apply to some scientific instrument firm, such as Messrs. Griffin & Tatlock Ltd., Kemble Street, W.C.2, or Messrs. Baird & Tatlock, Hatton Garden, E.C.1.

(2) The device, consisting of two swinging pendulums, one carrying a platform and the other a pen or pencil, was known as a harmonograph, and here again this was practically a mechanical novelty which seems to have entirely disappeared from the market. In this case, also, the two firms mentioned above would be the most likely sources of supply.

No. 9802.—Lighting and Battery-charging Set

A.S.G.W. (Comber, Belfast)

Q.—I am building a combined direct lighting and battery-charging set, using a 1,500 watt, 24 volt, aircraft dynamo driven by a petrol engine. I should be grateful if you could supply me with a diagram of the switchboard circuit incorporating the following items which I have purchased :—

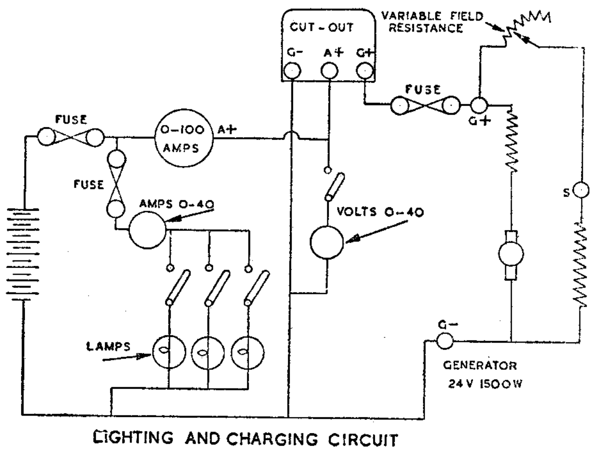
1,500 watt, 24 volt dynamo, one voltage regulator, accumulator cut-out, fusebox, four fuses, 100 amp. meter (with shunt), 40 amp. meter, 40 volt meter. The terminal markings on the various items are as follows : Dynamo (G+) (S) (G—); Cut-out (G+) (G—) (A+); Voltage regulator, (G—) (SW) (G+) (A—).

Also, would it be possible to use this dynamo for light electric welding, and what would the circuit be.

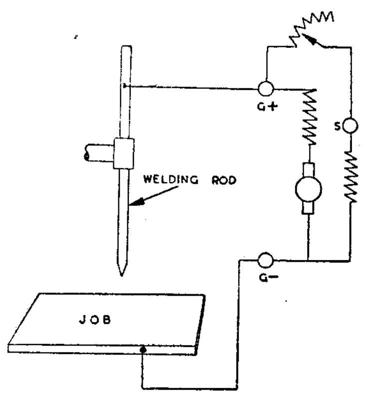
R.—Wiring diagrams for a lighting and charging circuit, and a welding circuit, are given here. It is not known exactly what type of aircraft generator you intend using, and we wonder if you are aware of the fact that most aircraft generators are designed to run in the region of 5,000 to 6,000 r.p.m. (unless the data plate on your model states otherwise) to achieve the rated output.

We quote the disappointing result obtained by one of our readers who coupled an aircraft generator direct to a petrol engine. At maximum engine speed (approx. 2,000 r.p.m.) and under no load conditions, the unit developed 2.00 *volts*. From this it will be appreciated that the generator must be run at a speed approximating to its designed speed. Assuming your petrol engine has an economical speed of 1,000 to 1,500 r.p.m., a speed step-up of 4 or 5 to 1 will be necessary. A vee-belt drive is probably the most convenient to use, but it should be borne in mind that an appreciable amount of power will be lost whatever type of speed increasing gear is used. The voltage regulator may, with advantage, be omitted, since its purpose is to prevent overcharging the batteries during extra long running periods, with no load on the batteries. Furthermore, generators and voltage controllers are " matched." Have you any proof that yours are matched ? Referring to the charging circuit, you will note that a variable resistance is necessary between the generator terminals *S* and *G*—. It is suggested that you try a total resistance of 20 ohms to regulate the field. The generator output will be controlled by means of this resistance which should be capable of carrying 10 amps.

It is possible to use the generator for light welding wired up as in the diagram, although it should be appreciated that generators designed for this purpose have a " drooping " characteristic.



LIGHTING AND CHARGING CIRCUIT



LIGHT WELDING CIRCUIT

No. 9808.—Material for an Electro-magnet

G.R. (Dagenham)

Q.—I have been searching most ardently for a piece of soft iron with which to make an electro-magnet. Having searched every scrap-iron yard and garage in this and outlying districts, I have drawn a blank. I therefore hope you may be able to help by telling me the whereabouts of a firm which can supply me with this apparently unobtainable material.

R.—The material usually recommended for making electro-magnets is Swedish iron, but you may find it extremely difficult to obtain this material at the present time. It will, however, be found that ordinary mild-steel gives fairly satisfactory results, if it is carefully annealed before use by heating to redness and allowing to cool as slowly as possible in ashes or some other heat insulating medium. We may mention, however, that in modern practice, electro-magnets are nearly always made with a laminated core built up from strips or stampings of sheet iron. If you decide to make a magnet of this type, we may mention that the strip material known as baling iron (which is used in the binding of crates) gives quite good results, but the precaution of annealing it before use is always advisable.